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AN EVALUATION OF THE IMPLEMENTATION OF TWO-LEVELS OF MAINTENANCE AT STRATEGIC AIR COMMAND INTERCONTINENTAL BALLISTIC MISSILE BASES

THESIS

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THESIS

Presented to the Faculty
of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the Requirements
for the Degree of Master of Science in
Logistics Management

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September 1991

<u>Preface</u>

A process known as the Defense Management Review has developed initiatives to reduce the costs of logistics in the face of austere budget forecasts without reducing our nation's defensive capability. One significant directive concerns the consolidation of non-aircraft/aircraft depot maintenance by applying alternative levels of maintenance.

This research effort investigated the suitability of a program implemented by the Strategic Air Command (SAC) involving two-levels of maintenance in missiles. An opinion survey of missile maintenance supervisors served as the data base from which an assessment, albeit an initial one, of suitability was made. From the data base, I present for my research information on opinion factors associated with implementation of the <u>Two-Levels of Maintenance Program</u> as outlined in the SAC/LGBM Document 90-4.

I am grateful for the contribution given to this thesis by a number of people, particularly Lieutenant Colonel Michael W. Sayer, Chief of the ICBM Maintenance Division at Headquarters SAC. My sincere appreciation is extended to my advisor and friend, Albert H. Rogers. Most importantly, a very special thank you for my understanding wife, Kim, and daughter Christy for their joy, love, and patience.

Alan H. Russell

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Acronyms

AFLMC-	Air Force Logistics Management Center
AFR-	Air Force Regulation
AFSC-	Air Force Specialty Code
AIM-	Alternatives to Intermediate-Levels of Maintenance
ALC-	Air Logistics Center
ALM-	Alternative Levels of Maintenance
AILM-	Alternatives to Intermediate-Level Maintenance
Ao-	Operational Availability
ATE-	Automatic Test Equipment
AWM-	Awaiting Maintenance
AWP-	Awaiting Parts
BIT-	Built-in-Test
CIRF-	Centralized Intermediate Repair Facility
DIFM-	Due In For Maintenance
DLM-	Depot-Level Maintenance
DTIC-	Defense Technical Information Center
DMR-	Defense Management Review
DoD-	Department of Defense
ERCS-	Emergency Rocket Communications System
FMC-	Fully Mission Capable
ICBM-	Intercontinental Ballistic Missile
ILM-	Intermediate-level maintenance
ILS-	Integrated Logistics Support
JQS-	Job Qualification Standard
LCC-	Life Cycle Cost
LHX-	Light Helicopter
LOGAIR-	Logistics Air (Transportation of supplies/parts, etc.)
LRU-	Line Replaceable Unit
MAJCOM-	Major Command
MCL-	Maintenance Change Logs
MOB-	Main operating base
MSE-	Maintenance (or Mission) Support Equipment
O & M-	Operation and Maintenance
OI-	Operating Instruction
OLM-	Organizational-Level Maintenance
OO-ALC-	Ogden Air Logistics Center
PACAF-	Pacific Air Force
PCA-	Permanent Change of Assignment
PCS-	Permanent Change of Station
PLSC-	PACAF Logistic Support Center
R & M-	Reliability and Maintainability
SAC-	Strategic Air Command
SRU-	Shop Replaceable Unit
TCI-	Time Change Item
TCTO-	Time Compliance Technical Order
TDY-	Temporary Duty
USAF-	United States Air Force

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Abstract

Taking the initiative under austerity fighting moves, Headquarters, Strategic Air Command has implemented a change to the ICBM maintenance concept. The change reprograms selected tasks to two-level maintenance from three-level maintenance. This action raises concern about the suitability of the change in the areas of: benefits of this maintenance change; effects on mission readiness levels and resource use; and potential for future reprogramming.

The literature review establishes the basis for alternative maintenance management concepts by looking at maintenance organizational theory, DoD guidance and management studies. These management studies include findings of increased pipeline times and difficulties in maintaining availability rates as a result of such change.

This study developed and analyzed questionnaire data from missile maintenance personnel at the wing level. The results of the survey infer this SAC ICBM program to be more of a problem than a help for wing-level operations.

The study concludes that efforts tc implement two-levels of maintenance within a mature system should expect difficulty in achieving significant results--the SAC program was no exception. The study also recommends addressing the issues of the increased spares requirements and the benefits versus pipeline costs under a changing maintenance concept.

AN EVALUATION OF THE IMPLEMENTATION OF TWO-LEVELS OF MAINTENANCE AT STRATEGIC AIR COMMAND INTERCONTINENTAL BALLISTIC MISSILE BASES

I. Introduction

General Issue

The delivery of logistics support consumes better than "one-third of the Defense budget" and employs a "similar fraction of Defense manpower" according to the February 1979 Defense Management Review (DMR). The "implications [from the DMR] make 'logistics' important . . . primarily because it is a crucial element of combat capability" (9:xii). Senior Air Force officials are looking for ways to streamline the services' existing logistics operations; especially in the face of declining budgets and arms reduction talks. The DMR initiative number 10042 takes a look at the major logistics functions in the Department of Defense (DoD) and offers some suggestions.

The problem of reduced resources (i.e., manpower, budget, etc.) suggests that select levels of maintenance be identified for elimination as one solution. The maintenance process for each weapon system in the Air Force is under review for ways to operate more efficiently while avoiding undue impact on weapon system effectiveness. The solution to low cost effectiveness may involve a modification to that system's maintenance concept, that is, seeking opportunities

that show potential for Alternatives to Intermediate-Level Maintenance (ALM). Many references are made to two-levels of maintenance by many different names and acronyms. This study will use ALM for Alternative Levels of Maintenance where necessary. This study looks at a program in the Strategic Air Command (SAC) missile arena that deals with alternatives to traditional maintenance.

As a precedence for work done in the missile arena, Headquarters SAC first carried out change in its aircraft maintenance arena. According to Captain Shurilla, Aircraft Maintenance Manager at SAC, the reprogramming efforts in B-52H and KC-135 aircraft maintenance units are producing significant annual cost savings (23). In a similar effort, missile maintenance managers have reprogrammed selected areas to two-level maintenance from three-level maintenance. The SAC plan, "Implementing Two Levels of Maintenance in ICBMs," Program Document 90-4, [1 December 1989] (see Appendix A) outlines the missile maintenance task reprogramming. The reprogramming of tasks brings with it the concern about the suitability of alternative levels of maintenance concepts for missile units. The program, as set up by Program Document 90-4, is the focus of this study.

Specific Problem Statement

This study investigates the effectiveness of SAC's conversion of select missile (ICBM) maintenance tasks from three-level maintenance to two-level maintenance.

Research Objective Questions

This study focuses upon six investigative questions about the problem statement. The research was guided by these questions to determine what missile maintenance managers perceive as the impact or suitability of SAC's program. The research questions are:

1. Of those areas considered and selected for conversion, what types and levels of maintenance have been applied to ICBM maintenance operations under the Program Document 90-4?

2. What have been the results of implementing two-level maintenance at ICBM Minuteman II, III and Peacekeeper units?

3. Was there a change in the mission readiness level (alert rate)? If so, how has the level (alert rate) changed?

4. Was there a change in the availability of mission support equipment (MSE)? If so, how has the level changed?

5. How has resource (manpower and equipment) use improved because of switching from three-level to two-level of maintenance?

6. Of those maintenance task areas not-selected for conversion at this time, which have the potential for change from a three-level to a two level maintenance scheme?

Limitations of Scope

The research concerns only the Strategic Air Command's missile wing units: Minot Air Force Base (AFB), Malmstrom AFB, Grand Forks AFB, Ellsworth AFB, Whiteman AFB, F.E. Warren AFB, and Vandenberg AFB. The study surveyed approximately 90 "key" maintenance managers to ascertain the

potential impact of these changes at missile wing units. A closer look into both the present maintenance concept and the issues currently facing senior Air Force officials will help define the impact of SAC's new maintenance program. This study also looked at the lessons extracted from other selected research and test program reports on the subject of two-levels of maintenance.

Definitions

Depot-Level Maintenance. The Air Logistics Center typically performs the depot-level maintenance function and handles all remaining repair actions (other than organizational and intermediate-level maintenance) necessary for rendering an item serviceable (13:12). This level of maintenance consists of those on- and off-equipment maintenance tasks not authorized or capable of being performed at the operating location. Depot-level repair services usually involve the most technically sophisticated or uncommon pieces of equipment. The Air Logistics Center (ALC), centralized repair facility, or, occasionally, an operating location will use personnel with the highest skills and special facilities of a supporting command. Maintenance done at the Air Logistics Center also may include organizational and intermediate-level tasks as negotiated between the operating and supporting commands (8:13).

Equipment Maintenance. Equipment maintenance ensures materiel readiness through the processes of restoring to serviceable condition and modification for updating or upgrading either on or off equipment (8:13).

Integrated Logistics Support. "A composite of the elements necessary to assure the effective and economical support of a system or equipment at all levels of maintenance for its programmed life cycle. It is characterized by the harmony and coherence obtained between each of its elements and levels of maintenance. (SECNAVINST 5439.72, NAVMATINST 4000.20, DoD 4100.35)" (5:356).

Intermediate-Level Maintenance. Intermediate-level maintenance requires a level of personnel skill and equipment in the middle range of technical sophistication. Concerns at this level of maintenance consist of those off-equipment tasks normally performed using the resources of an operating command at an operating location or at a centralized intermediate repair facility (8:13).

Life Cycle. "The life cycle embraces all phases through which an item passes from conception through disposition (AR 11-25) . . . . The total life span of an end item commencing with the concept formulation phase and extending through the operational phase up to its removal from the DoD inventory and ultimate disposal . . . (AR 78-13)" (5:390).

Life Cycle Cost. "The total cost of an item or system over its full life. It includes the cost of development,

production, ownership (operation, maintenance, support, etc.), and, where applicable, disposal (see AFR 800-11). (AFR 80-14)" (5:390).

Logistics. The understanding of logistics stems from the activities of industry and military management. Many definitions exist in an attempt to explain the term of "logistics." The United States Air Force (USAF) defines logistics as the: "science of planning and carrying out the movement and maintenance of forces . . ." (2:2). J.F. Magee has suggested the following definition: as "The logistics system includes the total flow of materials, from acquisition of raw materials to the delivery of finished products to the users . . . ." Magee also indicates that a firm or organization usually "directly controlled only a portion" of the product's logistic system (14:2). "The Society of Logistics Engineers (SOLE) has expanded the definition of logistics to 'the art and science of management, engineering, and technical activities concerned with requirements, design, and supplying and maintaining resources to support objectives, plans, and operations'" (2:4).

Maintenance. Supporting a base's mission is the main objective of any multi-level maintenance structure in the military. This DoD structure usually includes organizational, intermediate, and depot-level maintenance. At any level, maintenance objectives ensure optimum availability and use of installed equipment for production,

operational readiness, and safety of the equipment in use (3:3). In normal, day to day operations, scheduled maintenance seeks to prevent system failure, breakdown or inefficient operation (3:1). For example, environmental control systems require periodic maintenance to ensure the system's serviceability and efficiency of operation. Unscheduled maintenance is usually in response to an emergency, i.e., when the environmental system shuts down unexpectedly.

Off-Equipment Maintenance. This term refers to all activities of maintenance done in the shop rather than on the end-item. This normally includes remove and replace and functional checkout activities performed <u>away</u> from the major end item or weapon system.

On-Equipment Maintenance. This term refers to the activities of maintenance performed <u>on</u> the major item or weapon system. These activities include: remove and replace and/or simple system functional checkout actions.

Operation. "The phase [that] covers the actual [military action (28:804)] of the system. (AR 37-200, DoD 7000.7) A prescribed act or action performed by an individual or machine (or by people and machines) to some document or product. (AFLCR 400-5)" (5:490).

Organizational-Level Maintenance. In the Air Force, organizational-level maintenance is the lowest level in a multi-echelon maintenance system of skilled technicians and sophisticated equipment whose objective is to carry out a

combination of any actions "to sustain an asset's operational readiness consistent with the demands of operating forces" (3:iii). This level of maintenance consists of those on-equipment tasks normally performed using the resources of an operating command at the operating location (8:14).

Three-Levels of Maintenance. This term refers to the maintenance idea that calls for three levels of organization (i. e., organizational, intermediate and depot levels) to provide maintenance support for an operational unit.

Two-Levels of Maintenance. In contrast to other maintenance levels, this term refers to the maintenance idea outlining the organizational and depot level maintenance functions that provide maintenance support to an operational unit--with no intermediate repair capability involved.

II. Literature Review

Introduction

Many published works exist on the research and application of alternative concepts of maintenance. At the time of this study, the application of alternative levels of maintenance in missiles is not of as broad a scale or as widely publicized as that in aircraft maintenance. However, missile unit managers are developing innovative ways to streamline their maintenance operations. This chapter summarizes and relates to missiles, the information about general maintenance concepts and recent documented efforts about streamlining maintenance operations through alternatives levels of maintenance.

Justification

Maintenance management concepts began to evolve and to be refined before the establishment of the Air Force as a separate service. In the midst of the changes today, understanding the issues facing senior Air Force officials can also help us understand the potential impact of proposed alternatives to intermediate-level maintenance. Furthermore, valuable lessons may be learned from the recent attempts at the two-levels of maintenance outlined in research and test program reports.

Scope

This literature review covers recent publications (1979 to 1990) concerning maintenance organizations from both the theoretical and regulatory points of view. The primary sources of specific research projects and test programs involve alternatives to intermediate-levels of aircraft maintenance. This review includes the results of telephone interviews and an examination of publications from the Air Force Institute of Technology, the Defense Technical Information Center, and other DoD sources. The key theme of this study is an analysis of alternatives to the intermediate-level of maintenance and its application to the Intercontinental Ballistic Missile (ICBM).

Description of Treatment

Whenever a maintenance unit performs its activities, it does so under a given set of guidelines. The guidelines for maintenance have three primary sources: 1) logistics theory, 2) Department of Defense directives, and 3) Air Force regulations. Theory describes the concept of maintenance as an element in a series of logistics events. Directives and regulations provide direction and standardization to unit activities. Selected case studies, papers, and articles are discussed in this chapter to emphasize the lessons learned, and to underscore the experiences of implementing alternatives to intermediate-level maintenance.

Which maintenance concept is most suitable to a weapon system is one of the first decisions made during the system's early, acquisition phase. Several case studies describe the application of different maintenance concepts during a system's later, operational phase. The U.S. Army conducted a study of Two-Level (Aircraft) Maintenance. That study looked at the feasibility of either "adopting a two-level maintenance system, a mix of two-level and three-level systems, or retaining its current three-level system for [Army] aircraft maintenance" (24:xii). In another case, a Strategic Air Command pilot program studied an alternative maintenance routine to learn the effects on mission availability of B-52 and KC-135 aircraft assigned to K.I. Sawyer Air Force Base. In yet another study, the Pacific Air Forces (PACAF) Command operations at their Pacific Logistics Support Center (PLSC) involved two-levels of maintenance. Since the PLSC's disbandment in 1988, several reviews have analyzed its effectiveness and provided some lessons learned.

The Strategic Air Command broadened their initiative beyond the aircraft logistics by setting up a selective type of two-level maintenance within the ICBM weapon system logistics stream. Missile maintenance managers took their cues from the implications and lessons learned of previous studies and implemented a unique maintenance alternative to missiles.

Discussion of Literature

Standards (Guidelines) for Maintenance Organizations. It is the change in the mission environment that is the focus of this study. History has shown that a set of plans is subject to change over time due to changing business or mission objectives. A plan or set of guidelines designed to reach an organizations goals gives direction for that organizational activity. Any successful organization uses a plan to guide the organizational activity in its use of available input to produce an acceptable output.

The changing mission environment primarily affects two things: the "management and technical activities" of a new system under development and weapons systems already deployed. According to the Department of Defense Directive (DODD) 5000.39, Acquisition and Management of Integrated Logistics Support (ILS) for Systems and Equipment, Maintenance Planning, heads the list of ten ILS elements. The other nine elements include Manpower and Personnel; Supply Support; Support Equipment; Technical Data; Training and Training Support; Computer Resources Support; Facilities; Packaging, Handling, Storage and Transportation; and Design Interface. Any change in these planning elements will change the direction of organized logistics activity in the future.

Benjamin S. Blanchard provides the concept and theory behind the DoD "logistics." In the early stages of weapon system's development, a maintenance concept will be

established by a logistics support plan. That plan attempts to identify the best allocation of equipment, labor force, and other resources. Proper allocation is necessary to achieve a suitable combination of efficiency and economy for a certain level of effectiveness and mission environment. Concerning changing times, Blanchard states that with the trends of:

> Increased technological advances, and logistics requirements . . . logistic support [costs] . . . [and] the current economic dilemma of decreasing budgets, less money [is] available for both the procurement of new systems and for the maintenance and support of those items already in use . . . . One of the greatest challenges facing [managers] today is to meet the growing need for more effective and efficient management of our resources. (2:xv)

Blanchard describes the ultimate objective of a "system/product design process" as one which incorporates the "necessary logistic support" in a way that provides the best return for the dollar invested (2:xvi). The maintenance concept according to Blanchard is a fundamental description of the "overall system support environment in which the system is to exist" (2:105) see Figure 1. The Minuteman Intercontinental Ballistic Missile (ICBM) system, as described by Sanks (19), is a prime example of a cost effective system able to "perform the intended function" (2:18). "The outstanding R & M character-istics of the Minuteman allowed the Air Force to field it in far greater numbers than possible with earlier Intercontinental Ballistic Missile[s] (ICBM)" (19:2).

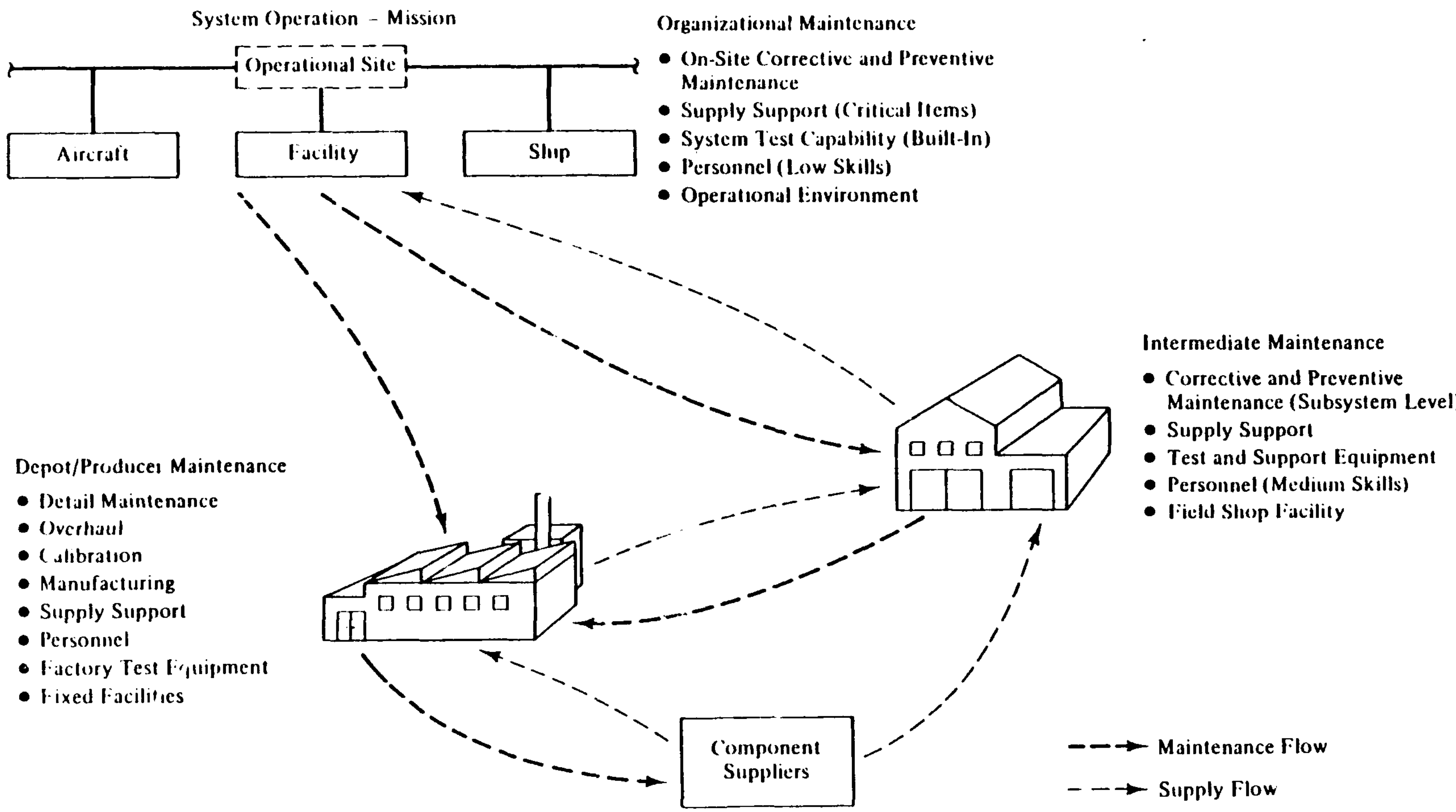

Figure 1. System Maintenance/Supply Flow (2:106)

Logistics considerations influence the availability, dependability, and effectiveness of any given system. For example, Blanchard suggests that, along with the ILS elements, the "support equipment (handling equipment), operating personnel, data, and facilities" are key logistics elements in any system operation. The measure of system effectiveness is ultimately through the "effect of the type and quantity of logistic support" (1:19). Furthermore, the logistics elements and effectiveness of a system determine the "maintenance and system down time" (1:19). The effectiveness of any given system depends upon its very logistics support functions. Figure 1 describes the flow of maintenance and supply lines under the maintenance concept. The maintenance concept incorporates these logistic functions into a plan with the following purposes:

> A. It provides the basis for the establishment of supportability requirements in system/equipment design . . . .
>
> B. It provides for the establishment of requirements for total logistics support . . . .
>
> C. It provides a basis for detailing the maintenance plan and impacts upon the supply concept, training concept, supplier/customer services, phased logistics support, transportation and handling criteria, and production data needs. (2:105)

Practically, the detailing of the plan ranges from the factors of "reliability," "maintainability," "supply support," "test and support equipment," "organizational," "facility," "software," "availability," "economic," and

"effectiveness" (2:viii). "Experience has shown that a major portion of the projected life-cycle cost for a given product or system stems from the consequences of decisions made during the early phases of programming and system conceptual design" (2:66). These decisions usually took place in the system's "advance system planning and conceptual design" stage (2:xvi). Minuteman II, III and Peacekeeper missile systems are now incurring costs implicated from decisions during the program's inception.

The maintenance concept is a fundamental element in any system design. The initial maintenance concept is vulnerable to change over time and any such change will likely affect subsequent post-production requirements and operational support criteria. Therefore, "[each] change must be thoroughly evaluated in terms of its impact on other elements of the system prior to a decision . . ." to make the change (2:287). Methods to control that change are necessary to preserve compatibility between all system element functions. According to Blanchard, these controls are a function of management "whenever any single given element is changed for any reason" (2:287).

Constant, accurate, and purposeful evaluation of the maintenance processes throughout the system's life-cycle reveal the potential areas for improvement for management. The reprogramming of taskings is done, whenever associated test and support equipment may be correspondingly changed, i.e., from intermediate-level to depot-level. The use of

intermediate-level maintenance test/support equipment at the flightline or at a missile site, however, may be limited due to adaptability, durability, portability, or a number of other reasons.

Measurement of logistic support should be based on the equipment progression through the system's life cycle and the necessary maintenance actions "to restore and/or retain the equipment in full operational status" (2:79). "The entire flow process must be treated as an entity." In a concise manner, from system inception to its retirement, Blanchard captures the interrelationships between the process functions in listed Figure 2. These process functions include: 1) "System design and development," 2) "Suppliers," 3) "Production/Construction (Prime Equipment and Support)," 4) "Depot Facility," 5) "Operational Site," and 6) "Intermediate Facility" (2:80). Therefore,

> The treatment of any single function must include consideration of the effects on other functions . . . . The goal is to develop an overall optimum logistic support capability by evaluating alternative configuration[s], including various mixes of the logistic support elements at each level. (2:81)

"Logistics Support Management involves planning, organization, direction and control [for] all functions and activities." The six basic program phases include: 1) "Conceptual," 2) "Preliminary system design and Development," 3) "Production and/or construction," 4) "Operational use," and 5) "System Retirement" phases (2:322-323). "[Program] phasing should be 'tailored' to the

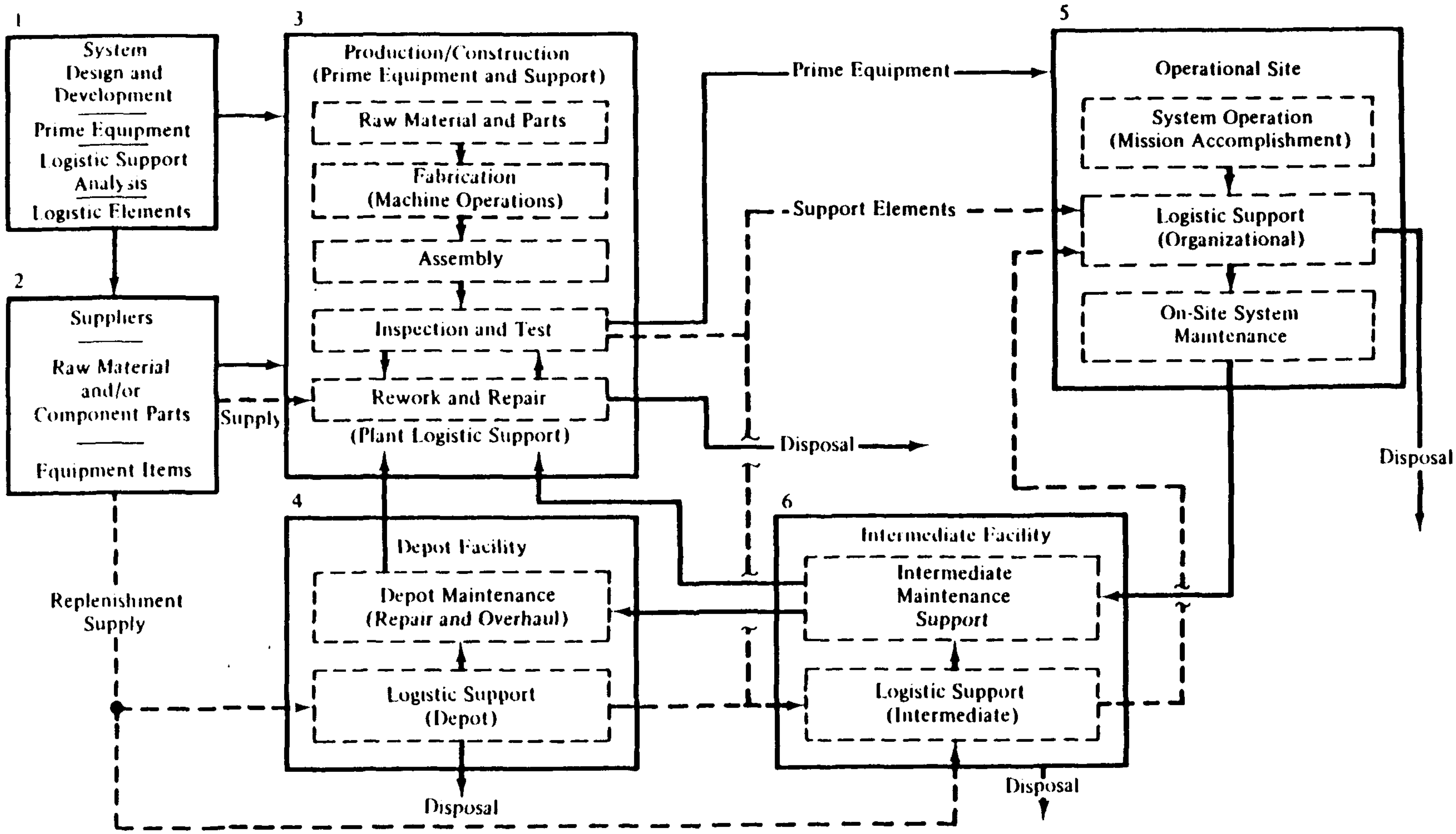

Figure 2. Equipment Maintenance Processes and Their Interrelationships (2:80)

system" and where necessary, "checkpoints [should be] provided at designated times in the program" (2:323). Where "risks] are low, . . . processing a system through all of the program phases may be unnecessary" (2:324); and fewer phases are less complicated. Figure 3 describes a system's typical life cycle phases and their relative costs.

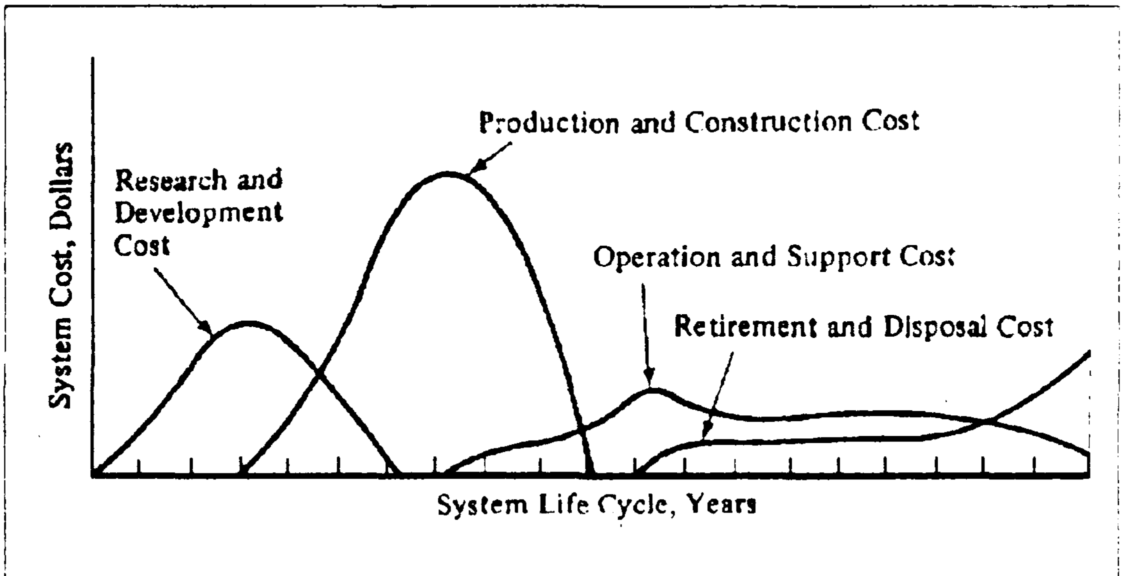

Figure 3. System Life Cycle Cost Phases. (2:72)

The life-cycle phases (especially the operational phase) of some systems have been expanded. Present ICBM systems are in their "operational/use" phase and the life expectancy of the Minuteman ICBM system, for example, has been extended due to the RIVET-MILE (Minuteman, Integrated Life Extension) modification. This modification is pushing the system to well beyond its original life expectancy.

With each life extension program, the dependability issue raises the cost consciousness of budget managers. Budget managers' concerns rise due to the conflict between shrinking budgets and rising costs associated with system/product operation and maintenance and upgrades, etc. The concept of life-cycle cost is only one aspect of cost, however, where "systems go through sequential cost stages, these stages typically include: a. Research, Development, Test and Evaluation (RDT & E); b. Acquisition; c. Operation and Maintenance (O & M); d. Deactivation/Retirement" (27:5-1). The processes that systems must enter through, create a complexity that requires an organized approach to manage them (27:5-1).

Department of Defense (DOD) Regulatory Control. The complex systems of the Department of Defense require a routine management organization that best suits the needs of each system. Since the establishment of the Air Force in 1947, "various commands [have] experimented with alternative maintenance organizational structures" to suit their own individual weapon system resource situations (18:8). The "discretion of local commanders and maintenance officers" (18:9) determined the maintenance policy for the local organization.

Lieutenant Colonel Thomas E. Reiter summarizes maintenance concepts and their application to the myriad of units in the Air Force. He concludes that a uniquely tailored maintenance organizational concept specifically

suited to a major command's mission is "the most effective way to manage and organize USAF aircraft maintenance organizations . . . " (18:iii). Reiter recognized that "no attempt should be made to standardize concepts Air Force wide" (18:iii). In 1953, the Strategic Air Command set the Air Force standard by achieving "excellent results in the conservation of technical skills, tools, facilities and materials" (18:9). The pioneering efforts of SAC and the subsequent standardization of maintenance practices, however, helped the Air Force to eliminate the "detrimental effects these haphazard and non-standard approaches were having on aircraft availability" (18:9).

In 1958, General Thomas D. White, then Chief of Staff, strongly supported the idea of centralized maintenance and espoused "a revised . . . AFM 66-1 [that mandated] . . . all USAF organizations [comply] . . . " (18:12).

> The new structure was designed to provide centralized control at the chief of maintenance level with decentralized execution at the maintenance squadron level and to organize and command maintenance in a functional way. It was still unit level maintenance [where] the 'Unit' was now a wing instead of a squadron. (18:12-13)

Today, the structure of maintenance organizations still changes to meet the needs of the Air Force and the DoD. "More recently, the focus of many studies has changed to reflect the Department of Defense's increased concern with readiness and sustainability under more austere circumstances. This shift has led DoD to act on

recommendations of the DMR intended to increase effectiveness by increasing the level of resources made available . . . " (10:xii).

The outcome of these studies influence the directives and guidance from the Secretary of Defense. From the Defense Resource Management Study of 1979, several design principles have emerged that call for consolidation of intermediate-level maintenance activities. The study recommended that the DoD:

> -Focus on maintenance capability of combat units . . . on quick-turnaround repair, limiting their need to perform off-equipment maintenance . . . .
>
> -Consolidate off-equipment maintenance at a level that permits capture of economies of scale and reduces the vulnerability of some support resources. (9:xii-xiii)

The Air Force Logistics Command (AFLC) operates industrial centers called Air Logistics Centers (ALC's) that support maintenance according to the type of mission. "The assignment of tasks and resources to operating units and AFLC should be negotiated between the operating Command and AFLC" (7:5). The negotiation considers "command, equipment and mission; [the balance between] peacetime economy, readiness and responsiveness with wartime effectiveness, flexibility, survivability and ease of sustainment" (7:5).

The resulting maintenance capability produces mission-ready systems through certain procedures dealing with on- and off-equipment repair functions. Headquarters United States Air Force (HQ USAF) authorizes "repair function

consolidation" when a variety of criteria are considered. Such criteria ranges from self-sufficiency to total costs of support (7:5-6). Negotiation makes economic sense. As time and components evolve, change for better system effectiveness may be in the offing. However, there is a limit to the extent of centralizing repair functions in considering the operation of any given weapon system. "Maintenance organizations must be ready to accomplish their wartime mission, [and] be adaptable to all environments where they must operate" (8:7). Peacetime production concepts, procedures, and processes that would limit an organization's ability to satisfy wartime requirements must not be used (8:7).

Task assignments depend upon a number of factors. These include the skills required, special equipment, processes or facilities at or planned for the operating location and ALC locations. "For units [that] will fight in place [such as missile combat units], however, this capability should be more highly developed into such facilities as a 'Queen Bee' repair center and may have some workload shared by AFLC" (7:6).

Systems can be designed to accomodate two, three, or more levels of maintenance. Some systems were originally designed with two levels of maintenance for their logistics support. Subsequent developments in the mission environment, however, may necessitate an alteration of that original design to meet the mission need at that time. Air

Force Regulation, AFR 66-1 Maintenance Management Policy, recognizes that change in maintenance needs is inevitable.

> The fact that three levels of maintenance are [now] used to maintain some equipment does not mean that all three levels will be needed or desired for future weapon systems or equipment . . . . Whenever a maintenance concept is developed or changed, the specific levels of maintenance required must be identified. (8:6)

Change in the maintenance requirements also changes the corresponding portion of the "[Bienniel] Planning, Programming, and Budgeting System [BPPBS]" (7:7). Before significant change takes place, however, "adequate resources must be obtained" so as to take advantage of resource trade-offs in "facilitating finding of the increased requirement." Any savings "should be . . . reinvested in the benefiting organizations as an incentive to good management" (7:7).

Maintenance management, at the major command level, is under pressure from budget concerns and is seeking ways to include modifications and streamlined maintenance procedures that improve "reliability, mission capable rates and save resources" (7:7). The Air Force equipment maintenance management regulation AFR 66-14 provides guidance in both general and specific terms.

> a. Provide MAJCOMS the policy and authority needed to develop tailored implementing directives. b. Stress that maintenance functions will be organized, personnel assigned duties and responsibilities, and individuals utilized to concentrate maximum resources on production. c. Eliminate nonessential, unproductive, and counterproductive procedures, tasks, and organizations . . . g. Ensure that policy,

organization, procedures, and personnel qualifications accomodate future missions, weapons systems, technology, and demographics . . . . (7:5)

The desirable maintenance production effort is one that is effective and efficient. Opportunities may exist to pare down logistics support requirements and consolidate maintenance functions or levels. The type of maintenance level (i.e., two or three) describes "whether the operating command or supporting command [either or both] are provisioned with the resources required" to do on- and off-equipment maintenance taskings (8:3). Tasks wi⁺ .ı each level of maintenance are categorized by "where they are performed in relation to the weapon system or end-item of equipment" (8:2). For example, in three levels of maintenance (Organizational, Intermediate, and Depot levels), each term refers to the end item, e.g. an aircraft, missile, communications facility, etc., and the corresponding maintenance actions done thereon.

The actions involved with "on-equipment maintenance" include the "test, repair, or removal" done on the end item (8:2). Maintenance actions done on a component away from the end item or weapon system indicates that "additional material [or skilled] resources are required" (8:3). These include: "off-equipment maintenance . . . tasks that are not or cannot be effectively accomplished on or at the weapon system or end-item of equipment, but require the removal of the component to a shop or facility for repair" (8:3).

In the ICBM missile maintenance arena, missile sortie generation requirements drive the workload at the operational level. In contrast, the frequency of flying schedules (peacetime and wartime) drive the aircraft maintenance workloads.

PACAF Logistics Support Center (Air Force). The significance of the Pacific Air Command's Centralized Intermediate Repair Facility (CIRF) lies in their operations at Kadena, AB, Japan conducted from 1976 through 1988. The PLSC's function successfully served as PACAF's single center for "intermediate [two-level] maintenance, theater distribution and associated logistics support for all PACAF assigned tactical aircraft . . . " (12:i). The purpose was to increase Tactical Air Command's flexibility during combat with the advent of base closures, sortie production problems and total demand on the forces. Manpower savings was not a main consideration.

Beginning in 1987, the PACAF Logistics Support Center (PLSC) began to decentralize due to the changing composition of TAC's forces and the decision to return intermediate-level repair capability to the wings (12:2). The wealth of knowledge from this central operation has provided a pool of "lessons learned" for future Air Force consideration of two-level maintenance on engine, and avionics items.

Three significant lessons were learned in Avionics repair. They dealt with base-level repair of jet engines, return of repaired items and the co-location of ALC at the

PLSC. The first lesson learned was the base-level repair of jet engines. Under the PLSC organization, PACAF bases were able to test LRUs (Line Replaceable Units) but were

> not authorized to place any items in AWP (Awaiting Parts) status. The LRUs were shipped . . . to the PLSC requiring only minor repairs. This tied up the pipeline and kept PLSC shops busy with repairs [that] could have been accomplished at the base level. (12:11)

Authorization for <u>local minor fixes</u> of items in AWP status would minimize PLSC congestion. However, the extent that items authorized for minor repair required only "minor" repairs is unknown. "Engines should be evaluate[d] for what tasks can be/should be accomplished at the wing level before giving blanket approval to take all intermediate [-level] maintenance away from the wings," according to this analysis (12:9). This repair action allowed PACAF forces to minimize turn around times by avoiding expensive and lengthy pipeline shipments for repairs that were only minor in nature (12:9).

The second lesson learned concerned the centralized return of repaired items from the PLSC. This return procedure allowed the removal of one item's part to complete the repair of another item when required (i.e., called cross-cannibalizations). Maintenance managers realized this procedure "decrease[d] the turn-around time" (12:11) for their parts. For lesson learned number two, the TCTO/TCI (Time Compliance Technical Order/Time Change Item) program management specifically needed to assign responsibility, not generalized it. The PLSC method of TCTO/TCI program

management tended to cause accountability and control problems within the supply system (12:10).

The third lesson learned involved the co-location of the ALC detachment, Det 35, Support Center Pacific (SCP), with the PLSC. This proximity of expertise brought "additional depot-level repair capabilities to the Pacific Theater." The presence of SCP enhanced the "flexibility [of PLSC] to react to changing repair and mission requirements." PLSC technicians increased their knowledge of depot repair capabilities and learned better ways to repair the intermediate-level items (12:12). There are some implications to missile units of a similar nature.

To reduce costs, missile units must consider the benefits versus costs before establishing any new management/handling positions as did PACAF's PLSC. The "[consolidation] of LRU/SRU repair actions under one supply account made macro/micro monitoring of repair cycle requirements for assigned weapons systems possible" (12:17). The report indicated this "centralized ILM should be supported by an autonomous account . . . responsible to the MAJCOM" (12:18). Secondly, the wing provided daily reports identifying "backorders, anticipated requirements and special support requirements" (12:18) . . . to the Supply Asset Push Distribution System. Though the system provided centralized visibility of customer requirements it had its failure in extra work and misshipments, etc. (12:18).

"Based upon PACAF's experience, it cost more to operate a centralized [intermediate-level maintenance] ILM (in terms of supply authorizations)" (12:17). Given the volume of movement in PACAF management, the extra cost was offset or spread over each transaction. The benefits of increased combat flexibility was justifying the existence of the PLSC. At present the volume of missile intermediate-level repair tasks transferred appears to not warrant such a similar system.

Alternative Levels of Maintenance Pilot Program (Air Force). This Air Force Logistics Management Center (AFLMC) pilot program, as with any test program, was purposed to determine whether an idea (a change in normal maintenance routines) was suitable for further implementation. The pilot program "measured and analyzed the impact of the Two-Level Maintenance" (15:i) on readiness of the respective systems at the K.I. Sawyer AFB and Warner-Robins Air Logistics Center (WR-ALC). One of the benefits of this study was its recommendations to "enhance the success of future centralized maintenance efforts" (15:i).

The AFLMC study provides lessons learned the significance of which may apply to future Air Force efforts. Lieutenant Colonel Chet Matthews concluded in his report that "the pipeline requirement is very sensitive to changes in order and ship time and depot repair cycle time" (15:i). He also indicated that "Two-Level Alternative Maintenance Concept should be used selectively--based upon reliability

of the system and the mission impact of spares" (15:i). A list of some of the lessons learned follows below.

First, "Unserviceable LRUs from K.I. Sawyer were given a special project code (251)" [that] resulted in an accelerated pipeline shipment time for reparable LRUs. Second, serviceable LRUs destined for K.I. Sawyer from WR-ALC received similar attention. Third, the "supply function had to use three different data systems to track reparables and to order parts . . . . Naturally, [this] was a manpower intensive task." Fourth, use of "serviceable LRUs from supply for troubleshooting could lead to unnecessary damage of those items and reduce the spares available to replace failed LRUs" (15:5-6).

For all of the special handling attention given this pilot program, it seems as though a better savings could be produced in turn-around time. For repair processing times:

> reparable items processed through [both] the base and the [ALM] [were very quick] . . . . The big difference in times between pilot and prepilot was the fact the repair facility was moved off base and thus the pilot repair time included additional transportation time (1.3 days). (15:15)

There were some "noteworthy exceptions" to maintenance procedures at K. I. Sawyer. Maintenance at the WR-ALC ALM was "accomplished . . . in much the same way . . . " (15:46) as at K.I. Sawyer AFB. The maintenance procedures at WR-ALC included the "consolidation of shop supervision" (15:40) and a savings in management overhead. In all likelihood, a

similar savings could be realized from a missile maintenance shop consolidation.

From the beginning, the pilot program did everything possible to enhance the measured result of "weapon system availability" (15:5)--the operation of which existed under an unusual logistics pipeline environment. The pilot program used extraordinary transportation arrangements to meet its objectives of repair cycle time. "[Dedicated] pallets and expanded LOGAIR schedules resulted in the delivery of K. I. Sawyer's LRUs to the [ALM] in less than one day in nearly every case" (15:35). Changes in handling priorities enabled "K. I. Sawyer demands [to] compete with the demands of other users . . ." (15:4). However, according to Matthews, the pilot program showed that potential does exist when there is insufficient repair capability to meet local demands for high failure items.

The unusual management techniques, i.e., special handling priorities, etc., in the logistics pipeline environment may be impractical and unsustainable under <u>broader</u> implementation. The implication and assumption of longer pipeline times <u>with</u> special attention is even longer pipeline times <u>without</u> the special attention. The lesson of this report is for a similar application of centralized maintenance. Any such application may fail to enhance the present maintenance system unless a selective implementation was chosen--the recent SAC missile program is a selective implementation.

Two-Level (Aircraft) Maintenance Study, Phase IIA (Army). As other studies are referencing, this study also finds two-levels of maintenance is best applied during the planning stages of a system. The Joel Steine report extensively analyzes the impact of two-levels of maintenance on a number of Army systems. The Army's study on different air fleet maintenance level combinations concluded that:

> the most effective alternative is . . . to continue its planned two-level maintenance [concept] for the LHX [Light Family of Helicopters] [in development], but retain its current three-level system for all other current aircraft. (24:iii) [The] three-level system is more effective than a two-level system for current fleet aircraft .... [due to] 1) insufficient personnel [authorized under the two-level] . . . and 2) [the fact that] more personnel are required to support a two-level system than a three-level system . . . . (24:xiii)

The Army study bases its findings on a set of maintenance system standards. The study considered alternatives and made determinations for each whether "feasible or not feasible based on minimum standards." Such standards include operational availability (Ao), battlefield displacement factors and resources required. "For type aircraft, goals range[d] from 70-75 percent [based on Army Fully Mission Capable (FMC) Aircraft Materiel Goals in AR 700-138]" (24:xiii). Similar standards drive missile logistics capability as well, however there are additional and different considerations.

Necessary and critical safeguards to the ICBM system operation ensure its fullest availability and include

specific safety, and surety factors. The high maintenance standard of the Fully Mission Capable (FMC) status sustains the missile operational availability. There is no mobility requirement for missiles. However, whether we are in peacetime or in wartime, the main operating base (MOB) will fulfill any maintenance contingency or generation requirements.

The Army's study defined two-levels of maintenance as the following:

> "The Two-Level concept . . . consists of two task levels--Aviation USER and DEPOT maintenance. The USER will [do] on-aircraft maintenance tasks only and will not [do] maintenance in support of the supply system. The supply system will be consistent with current supply procedures to support USER maintenance. The USER level will be structured to [do] maintenance that will include on-site repairs, diagnostics and prognostics, and surge maintenance. Depot level maintenance will be structured to [do] all maintenance in support of the supply system and those extensive on-aircraft repairs beyond the capability of the USER. (24:xvi)

For a suitable description of a two-level maintenance application in missiles, substitute the term "on-aircraft" with "on-missile." The difference between two-and three-level maintenance, according to Steine, is the responsibility of "off-aircraft repair and the repair of components for return to the supply system." The remaining functional levels are organizational and depot, hence, a two-level system (24:xvii). For a reasonable description

of missile maintenance, substitute the term "off-aircraft" with "off-missile."

There is a difference between aircraft and missile maintenance workload requirements during the peacetime and wartime environments. The flying hour rates drive aircraft maintenance production. Any increase in flying hours under wartime conditions directly generates an increase in "workloads base[d] on scheduled and unscheduled maintenance and combat damage . . . " (24:xix). Steine's report cites a personnel shortfall (or lack of manpower) under either maintenance concept (two-or three-level), however, the two-level incurs a greater shortfall.

When comparing [three-level] maintenance capability versus workload, the Army study found "the capability (available maintenance-man-hours) is greater under [three-level] than [two-level]." This is due to mobility requirements attaching non-maintenance related duties "such as unit moves (displacement) and security (area defense)," when moving further forward on a battlefield (24:xx). Also, the intermediate-level maintenance units that remain to the rear "have a greater [maintenance manhour] MMH capability per person . . . " (24:xx). "Under the two-level maintenance scheme, the [intermediate-level units] are removed from the force structure and their personnel assets move forward to [organizational-level] support . . . . These numbers of personnel become less productive as a result" (24:xxi).

In contrast, the missile community bases its work force requirement on the daily maintenance and generation need. Wartime scenarios would likely not increase the missile maintenance workload except for a short burst of effort to generate all off-alert sorties. Under wartime conditions, the workload would be handled in-house and on-station with trained maintenance crews--unlike some aircraft units that mobilize to a theater of operations.

Minuteman: A Model R & M Program (Air Force). The acquisition environment during the late 1950s and early 1960s insisted on high reliability and maintainability for the Minuteman program. In this article, Major Julius F. Sanks uncovers the concepts used from the inception of the Minuteman missile systems. Concepts which are fundamental to the weapon systems successes through recent decades and concepts which were pioneering in the business of system acquisition. According to Sanks, "it is assumed program managers did not face the fiscal and scheduling constraints we see today." Yet, "developers of Minuteman faced these same obstacles" (19:2) as do modern program managers face today. Today, providing sufficient force in the face of technological risk, budget constraints, strength parity and politics represents a continual struggle for new program managers. The attributes of the Minuteman system still hold true today. Some are listed below.

> The Minuteman program, the first of its kind to use solid fuel technology, was shaped by the demands of "low cost and rapid [time

> requirements for development]. To meet the threat, the new system had to be available in large numbers and have a short response time to allow launch before destruction by incoming reentry vehicles. Large numbers required low acquisition cost and low operations and maintenance costs. (19:2)

The focus in the new ICBM program was on work force savings.

> [The program] continued with the maintenance concept . . . . [Electronic] drawers in the Minuteman program . . . were [designed] to reduce [failure rates and improve high reliability] and [to reduce] the time the maintenance technician had to spend on site [maintainability] . . . . Minuteman's BIT [built-in-test monitoring system] was designed to minimize on-site checkout [actions]; it identified what part of the missile had failed . . . . On-site, technicians performed maintenance with a minimum of experience. (19:5)

From its inception, the Minuteman program has set a tradition of "high reliability and combat readiness," for subsequently acquired weapon systems. The Minuteman, known as the "Silent Sentinel," is usually taken for granted that it will always be ready. The facts speak for themselves.

> The Minuteman program achieved such success not because of the benign environment 'in the hole,' or because the design was a simple one. It was because the program managers [at the program's outset] were willing to emphasize reliability and maintainability from the beginning. (19:6)

After more than thirty-two years of being on alert, the Minuteman system has undergone major physical modifications to enhance its effectiveness. Its longevity continues to be sustained through modifications (e.g., the RIVET-MILE or Minuteman Integrated Life Extension program). It remains

the foremost, cost-effective cornerstone of this nation's defense providing one of the three legs of the Strategic Triad. The Strategic Air Command continues its innovative pioneering with the introduction of a change to the way it conducts missile maintenance operations.

Implementing Two-Levels of Maintenance in ICBMs (Air Force). The SAC innovation continues with the Program Document 90-4, see Appendix A. This initiative reviewed intermediate-level maintenance (ALM) performed done by the missile Electronics Laboratory (E-lab). The intent was to "relocate" selected tasks to the ALC "depot-level" or to the units' maintenance "organizational-level" to reduce maintenance costs and improve maintenance capability (6:23).

Following Air Force Chief of Staff approval, approximately "[Fifty-one] E-lab Job Qualification Standard (JQS) tasks were slated for reprogramming to The [Ogden] Air Logistic Center" (20). The command conducted the initial review among the diverse configurations of the six missile wings and one test missile squadron and concluded a phased approach to the implementation would be best.

The criteria of selecting tasks are listed below and in Appendix A. They involve careful review for the following for each eligible task: 1) a high mean time between failure (MTBF); 2) difficulty in maintaining proficiency on that task, i.e., a seldom performed tasks; 3) long lead times to receive parts at units, etc. (21). With the identified tasks now transferred to the ALC, no further movement is

planned at this time according to Lieutenant Colonel Michael W. Sayer, Chief, ICBM Maintenance Division (21).

According to the SAC plan and through the action of transferring maintenance responsibilities away from the unit, "some savings are being/will be achieved" (6:3). These potential savings include reductions or elimination of: "Utility cost, training manhours, tester maintenance hours and parts plus the turmoil associated with maintaining proficiency on seldom performed (1-2 times a year) tasks" (6:4).

The implementation in missile maintenance was not formally measured as one might understand measurement in the traditional sense--that is, regularly employing an analyst to evaluate the effect(s). Maintenance managers at SAC surmised the expenditure of resources for measuring the effect of the SAC plan, e.g., labor and computer time, as defeating the objective to save on costs. Hence, no full scale analysis has been performed.

The objective of the plan was partially fulfilled for a relatively few number of tasks. A review of other shop tasks found similar reprogramming opportunities. However, given the present and stable force structure, the opportunities were lacking worthwhile benefit or had limiting factors.

At Last Maintenance Gets Its Due. As General Counsel to the Department of Defense (DoD), William H. Taft, IV,

wrote about maintenance as being a significant portion of the business in the Department of Defense operations.

> We keep some 900,000 individuals around the world busy maintaining more than $200 billion worth of weapons and equipment in good working order. We estimate our annual expenditure for maintenance is more than $40 billion. When budgets are tight, it is always tempting to preserve long term procurement programs at the expense of immediate operating needs. Tempting, but very short sighted. (Based on remarks to the Aerospace Industries Association Maintenance Symposium, Mar. 27, 1985.) (26:29)

The cost of maintenance is about twenty percent of that expended for weapons and equipment. The tendency of budget conscious program overseers is to hold back allocations for maintenance (costs/expenses) in order to spare the long term programs from cuts. The lesson here is that maintenance managers should always be looking for ways to reduce costs of operations according to Taft.

> The strength of our deterrent depends on being ready to meet a crisis. It also depends on using the qualitative superiority of our people, weapons and equipment to offset the Soviet's superior numbers" (26:30) . . . . The services are improving the efficiency of their maintenance work force by moving technicians out of the shops [and] onto the flightlines. (26:31)

According to Taft, funding targeted areas yielded specific results. The "Hollow Army," as the services were called during the Reagan Administration, demanded the nation's emphasis be placed on making substantive improvement in the services. With the fresh influx of capital, improvements in spares levels, adequately equipped

technicians and other maintenance budget necessities became a reality.

The business of maintaining some of SAC's aircraft recently got a boost in the efficiency of its operations. Certain maintenance management initiatives are seeking to capitalize on past Reliability and Maintainability (R & M) improvements. The flightline is seeing more maintenance people in a recent reorganization to cut costs. The B-52 and KC-135 avionic maintenance units are experiencing these type of reassignments, which are moving people out of the shops. Any similar application in missile maintenance may be an answer with a lower magnitude of scale.

Councilor Taft recognizes the importance of reducing costs and the lead time required for acquisition of new systems. He points out that we must "be careful not to wait until a system is nearing deployment before we consider [such items as] . . . logistics, manpower and training support" (26:31). He reemphasizes the necessity to "invest now to improve the reliability of our new systems and reduce their maintenance burden" (26:31-32).

<u>ATE: The Push for Two-Level Maintenance</u>. The concept of two-levels of maintenance is becoming more attractive to senior level managers because new technologies may keep system operation and maintenance overhead costs down. New programs, such as the Advanced Tactical Fighter, incorporate technologies that "support a move away from the current three-level system of maintenance" (4:55). These "[new]

technologies will permit next-generation aircraft . . . to bypass the costly and time consuming intermediate level of maintenance" (4:55). Advanced electronics and universally interchangeable avionics modules are just some of the objectives the services are moving "to shorten the logistics tail." These objectives, according to W. A. Demers, will be achieved by "developing standardized and more compact test equipment" (4:56).

New weapons system programs will have as their goal: the achievement of two-level maintenance. According to Demers,

> Under the two-level concept, maintenance technicians will rely on a weapon system's integrated diagnostics or built-in test (BIT) capability to identify and isolate a failure with a component . . . . a replacement is snapped into place and the removed item sent back to a distant depot for repair and subsequent repatriation into the supply chain. (4:56)

At issue is the feasibility of "paring down levels of weapons maintenance" (4:56). Many factors complicate the issue of going to "two-levels" of maintenance. This is according to Frans Nauta, a senior research fellow at the Logistics Management Institute (LMI) who follows reliability and maintainability (R & M) issues. These complicating factors include: "operational environment, a peacetime or wartime scenario, a system's R & M characteristics, the spares system, and the availability and skills of maintenance personnel" (4:60). These factors also influence system design choices and ultimately the "logistics tail"

supporting the maintenance burden. According to the chief of logistics support for the Army's Light Helicopter (LHX) program, it is necessary to replace the "Manpower- and stock-intensive maintenance structure" . . . with a structure "that involves pulling off a servo, replacing it[,] and getting the aircraft . . . in the air."

Demers is citing the critical need to, early-on, design in "two-level" maintenance as a strategic method to reduce the logistics burden later-on in a systems' deployed, operational phase. Special maintenance consideration is necessary given that this LHX helicopter is increasingly becoming a "host platform" for a myriad of electronic "combat aids." The LHX helicopter unit(s) need specific logistics support, for with its many line items, the logistics tail "is quickly becoming unwieldy" (4:62).

Summary

This literature review discussed the environment which influences the development of maintenance organizational structure. The chapter also presented discussion from Department of Defense regulations and directives and from maintenance management theory. Air Force Regulations 66-1, 66-14, 800-8, and 800-18 provide the guidance, however, new directives from DoD are driving the reevaluations of present maintenance operations. The results are Defense Management Review studies that point to Alternatives to Intermediate-Level Maintenance as a change that offers hope in this

fiscally austere budget climate.

The chapter also considered various studies and programs (one Army study, one PACAF study and one SAC test program) all of which focused on evaluating alternatives level of maintenance. The PACAF purposely existed for eleven years for non-logistics reasons, while the logistics test programs were of much shorter duration. Each sought to consolidate logistics functions between operational and support units. With one exception, that being the PACAF PLSC, the results of each study pointed to the increased pipeline times and difficulties in maintaining availability rates. The PLSC exception reinstated the so-called <u>three-levels of maintenance</u> after a PACAF force restructuring. This lead to the disbandment of the PLSC after a unique and lengthy in-service time.

Whatever the proposed changes, Lieutenant Colonel Reiter poses some recurring factors:

> It is [interesting] that part of the justification for every change in structure inevitably was the same two factors. They are[:] 1) the need to produce more aircraft [sorties] for operational use, and 2) the need to make the most efficient and effective use of available resources, both people and equipment. The real irony is that these justifications were used regardless of the nature of the impending change. (18:33-34)

The subject of implementing of two-levels of maintenance is approached with intent to identify the measure of organizational standards and the lessons learned. The results unanimously point to the <u>designing in</u> of two-

levels of maintenance into the early stage of a weapon system's development. Any attempt to change a maintenance concept for a savings effect invites difficulty in doing so. The implementation of the SAC missile maintenance program was left largely undocumented due to the small scale of economic benefit. The missile program's low benefit-to-cost ratio did not justify any substantial investment for measurement of the program's effect. This study involves itself with the research problem of investigating the suitability in implementating the plan as outlined in SAC Program Document 90-4, Implementing Two Levels of Maintenance in ICBMs.

III. Methodology

Overview

The purpose of this research is to determine the suitability of implementing a "two-level" maintenance concept for ICBMs. The study's goal is two fold. First, to learn lessons about management's experience with Strategic Air Command's recent reprogramming of select Electronic Laboratory (E-lab) tasks. Second, to seek how missile maintenance managers view the potential for local change in the maintenance concept.

The literature search developed a knowledge base for the research. The principle data collection instrument used the mail questionnaire format because of its versatility and economy in its application. This chapter describes the target population and outlines the survey instrument design. The data analysis procedure describes how the locus of opinions was formulated from which conclusions are drawn.

Literature Search Methodology

This research proceeds from an established knowledge base known as the literature review discussed in chapter II. The literature review provides both primary and secondary source information about the two-level maintenance concept and develops the rationale for the survey content.

The major sources of information were: the Air Force Institute of Technology Library, the Defense Technical Information Center (DTIC), the Air Force Logistics Command, and Strategic Air Command. The query into library and DTIC sources used such key words as: maintenance, aircraft/missile maintenance, and maintenance management. Specific points of contact within the Air Force Logistics Command (AFLC) and the Strategic Air Command (SAC) headquarters assisted in obtaining information on the recent history of Air Force two-level maintenance conversion(s).

Data Collection Instrument: The Questionnaire

Purpose. The data collection instrument was an opinion survey, mailed as a questionnaire and a sample is shown in Appendix B. The versatility and economy of the survey makes this technique ideal for obtaining opinions, attitudes and expectations (11:158).

Structure. The survey structure places simpler questions early, moving toward the more complex. The consistent use of the Likert answer scale, uses this frame of reference to avoid any misaddressed questions or unduly influenced responses. Questionnaire development centered on structuring a clear set of questions for the respondent on the subject of two-levels of maintenance in missiles. Each question is a translation of and supports the investigative questions previously stated in chapter one. Classification of questions into categories is intended "to aid the

respondent in replying with the minimum of difficulty and the maximum of reliability" (11:202). The validity and reliability of research data are discussed in appropriate sections later in this chapter.

The questionnaire stated its purpose clearly and requested demographic information and opinion type information on technical issues. Both open-ended and closed-ended questions were be used to gather the principle data. The closed-ended questions dealt with points developed from problems areas discovered in the literature review. The closed-ended questions also focused on the respondent's opinion on issues concerning the recent SAC ALM program.

These areas are:

1. Results of implementing two-levels of maintenance in the Electronics Lab.

2. Change in mission (support equipment) readiness levels.

3. Resource utilization (manpower, test equipment, etc.)

4. Potential for further implementation in other shop areas.

5. Problem areas--pertinent to research.

The final section of the survey instrument used open-ended questions to allow all participants an opportunity to comment. Open-ended questions referenced the subject areas concerning problems with and opportunities/non-opportunities for implementation of two-level maintenance. This type of

question allowed the respondent to reply with additional comments on the research subject. The following sections outline the content of the questionnaire.

Demographics Content. The first section of the survey requested demographic information about the respondent. The questions requested the following information:

1. Number of years with the government.

2. Present job title.

3. Number of years assigned to present job.

4. Level of experience with E-lab and other shop activities.

Questionnaire statements numbers 1 through 11, shown in Appendix B, asked for information on whether the respondent is currently involved with, has worked with, or expects to work with certain shop activities. These demographic data will be used to classify the respondents and assist in the survey data analysis discussed in chapter IV.

Opinions Content. The second section requested facts and opinions of all survey respondents using open-ended and closed-ended question/statements. The participants were asked to reply to each question using a Likert scale for most statements.

Target Population. The research considers inferences developed from the collected data. To do so necessitates describing a "population" and a "sample" of that population. According to McClave and Benson, a population is "a set of data that characterizes some phenomenon . . . . about which

we wish to make an inference" (16:5, 1134). In this research, the population is the community of missile maintenance managers and supervisors assigned at the Strategic Air Command's six strategic missile wings and one test missile squadron. These managers and supervisors are active duty Air Force officers and enlisted personnel--each uniquely qualified in the subject area.

According to McClave and Benson, a sample is "a subset of data selected from the population" (16:5). The sample in this study consists of personnel occupying specific office positions. These positions include the following: Deputy Commander for Maintenance (DCM), Assistant DCM-Production, Field Missile Maintenance Squadron (FMMS) Commander, Maintenance Supervisors and Superintendents, the Electronics Laboratory Shop supervisor, the Quality Assurance representative, and other technical positions--all totaled, approximately 32-38 persons per wing. Appendix E is the distribution list of the offices polled in this study.

The questionnaire's primary reference source is the SAC Program Document 90-4, Implementing Two-levels of Maintenance in ICBM's. This source document was used to guide the implementation of "Two-levels of maintenance" at missile units and is provided in Appendix A.

Data Collection: The Survey

The survey instrument package (see Appendix B) was distributed to specific SAC missile offices as described in

the target population section and in Appendix E. Each respondent was asked to return the survey material to the researcher within ten days of receipt or as soon as possible. The survey material was returned by mail using self-addressed envelopes and collected to assemble the data for the analysis.

Data Accounting and Analysis

Chapter IV presents the research results, analysis and comments. Making sense of the research data depended upon the survey instrument design for type of data collected and reliability of the data.

Type of Data. The type of questions used determined the way the data was collected--computer coded and written type responses. These are further described in the Data Collection Instrument section of this chapter.

First, for computer-coded type of data, using closed-ended questions, instructions directed that each response be made by marking the answer sheet according to a Likert scale. Each mark corresponded to one of these five terms (from left to right on the questionnaire): Disagree Strongly, Disagree, Neutral, Agree, Strongly Agree.

The Likert scale, a summation type scale, corresponds to the terms used and is well suited for closed-ended questions. The Likert Scale associates the degree with which the respondent agrees or disagrees with the statement variable (11:255-7). The measure of the computer coded data

is of rank order and "the appropriate measure of central tendency is the median" (11:89). The raw data is tabulated using a machine scoring process for further analysis.

Second, for the written responses, the open-ended questions elicited comments from many respondents. The comments are edited, summarized, and listed for conciseness in Appendix C.

Validity of Data. The extent to which the subject area is sufficiently covered (the adequacy of the survey content) determines the validity of the research questionnaire. To ensure adequacy of coverage and avoid the tendency toward questionnaire bias, Lieutenant Colonel Michael W. Sayer, HQ SAC/LGBM, Chief of the ICBM Maintenance Division, reviewed the survey. "Bias is the distortion of responses in one direction" (11:215). Personnel at the Air Force Institute of Technology also reviewed the survey for consistency and readability.

Reliability of Data. The conditions of the survey's administration determine the reliability of the survey instrument. The test of survey results uses a simple test for equivalence. This test measured the presence of error due to the difference of sample items studied (11:99). In assessing the measurements, this study used a single sample, parametric alpha test to check for goodness of fit (11:302-3). A principle factor analysis was needed and did assist in finding statements that were answered along a common theme in the overall survey response. The

credibility of the survey results were then determined from these comparisons.

The test for goodness of fit compared the observed distribution of response data, among categories, to that of the expected distribution. The sample size was ninety in an estimated population size of one-hundred-seventy. This study learned how respondents varied in their responses from variable to variable and how well certain variables categorize the respondents. However, due to the smallness of the survey return rate each factor (or statement) required further "factor" analysis. The factor analysis identified a more fitting arrangement--other than the original pattern. The new grouping provided a basis to obtain reliable and therefore more interpretable results and analysis.

Summary

This chapter outlined the procedures used to collect, analyze and report on the survey instrument data. The importance of the literature review and data collection methodology was discussed in terms of each research objective. Developing the data collection instrument (an opinion survey) included the aspects of validity and reliability. The check for reliability included a principle factor analysis to improve data interpretability. Chapter IV provides the analysis of data collected.

IV. Research Results and Analysis of Data

Overview

This chapter presents the study's research data on the subject of two-levels of maintenance in ICBMs. The analysis of the sample survey data addresses the research questions developed in the first chapter. This chapter further describes the survey's rate of return, its confidence level for the data, and the data reformatting operations performed. The reformatting was necessary to render the survey data reliable and interpretable. The data reliability check is discussed in this chapter. Finally, the research results are used to answer the research questions.

Survey Return Rate

Twenty-five days were given between distributing the questionnaire and terminating the collection of the survey. The overall survey return rate was 58 percent. However, only 40 percent of those surveys distributed responded to the survey statements numbered 12 through 26, the opinions content. The return rate is described in Table 1 below.

Confidence Level

The survey data returns came back at a return rate sufficient to establish an 0.88 (25) confidence level.

According to James T. McClave and others, the idea of confidence level concerns the "probability that an [sample] encloses the population parameter, if the [sample] is used repeatedly a very large number of times" (16:334).

TABLE 1

Survey Return Rate (17)

Estimated Population	Sample Size	Surveys Distributed	Surveys Returned	Return Rate (Usable)
168	88	88	51	58% (40%)

Data Operations

Manipulation of data into a usable format facilitated the analysis of the data. Data was requested and received in two modes. One, by a computer coded answer sheet indicating the respondent's responses to the survey's closed-ended questions. These responses were assembled using an optical scanning device and placed into a block format for analysis. Simple counts and percentages of question/statement responses were computed (see Appendix C). A test for data reliability was conducted using the Statistical Package for Social Sciences (17) (see Appendix F).

The second response mode was in written form. These answers, to the open-ended questions were reviewed, manually tabulated, and summarized based on the main points

identified by the respondents. For the most part, each answer was unique; rarely agreeing on one item. See Appendix C for a concise edited summary of these responses.

Validity Test

The survey instrument validity is deemed sufficient by the pre-survey review for content as discussed in Chapter III.

Reliability Test

Reliability, "is a necessary but not a sufficient condition for validity" (11:98). Reliability of survey data concerns itself with the "variations at one point in time among [respondents] and samples of items" (11:99). The reliability analysis determined the goodness of fit the survey data had with the original survey design. That is, a common theme was measured in the survey as designed. Each questionnaire statement is associated with a keyword and is used for identification during the analysis. Table 2 below shows the survey statement number and it keyword(s) variable name.

Reliability Analysis

The concept of reliability centers around estimates of the degree to which a measurement is free of random or unstable error" (11:98). Reliability analysis of the survey data indicates a low reliability between the questions as

grouped in categories listed below. The Statistical Package for the Social Sciences (SPSS) analyzed the data grouped according to the categories in Table 2: Implementation of Two-levels of Maintenance, Mission Readiness and Resource Utilization. All measurements were taken within a 25 day window across all missile wings. The consideration in this reliability analysis is "how much error may be introduced by . . . different samples of items being studied (in questioning or scales) . . . . [E]quivalence is concerned

TABLE 2

Original Grouping for Survey Variables

Category	Survey Statement No.	Associated Keyword
Implementing	12	planned
	13	implemented
	14	implementation complete
	15	seldom performed
	16	proficiency
Mission Readiness	17	leadtime
	18	alert rate impact
	19	spares impact
	20	no spares problems
	21	dedicated equipment
Resource Utilization	22	sufficient equipment
	23	significant maintenance
	24	shop utilization
	25	shop training
	26	personnel movement
	27	top-five tasks
	28	comments

with variations at one point in time among . . . samples of items" (11:99). The reliability test of the data shows the respondents did not perceive the survey questions all the same way. Using the Statistical Package for the Social Sciences (17) computer program the reliability analysis reveals the survey data variables, as grouped, do not statistically measure a common theme. The problem may rest in the perception of the people responding to the survey.

The survey data proved that the initial arrangement of the original fifteen statements (variables) yielded results too "weak" to be reliably interpreted. The results of original groupings indicated that people tended to respond in a "relatively homogeneous" manner across the survey variables (22). That is the survey, as answered by the respondents as a whole, did not measure a common theme. Therefore, the survey reliability as designed is poor. This necessitated further analysis to determine which items, if any, naturally grouped together according to the responses. The responses were clearly not parallel. In the statistical sense, there is an alternative, logical grouping which may define some parallel, or similarly patterned, responses in the responses as a whole. Using the "principal component" approach in the factor analysis, a new grouping isolated eight of the original fifteen variables. Table 3 shows the new grouping by statement number and its variable name.

Appendix C presents the observations to each survey item and the corresponding percentage. Appendix F provides the

reliability-alpha value for both the original grouping and the new grouping.

Survey Results

Demographics Results. Respondents from the strategic missile wings and the test maintenance squadron were asked to participate in the opinion survey. All seven bases did respond. The proportions of wing responses are indicated below. Within the fifty-one returns, one return was not traceable and did not indicate grade or AFSC (Air Force

TABLE 3

New Grouping for Survey Varia es (17)

Category	Survey Statement No.	Associated Keyword
Program	12	planned
	13	implemented
Elements	15	seldom performed
	16	proficiency
	21	dedicated equipment
	23	significant maintenance
Impact	18	alert rate impact
	19	spares impact

Specialty Code). One respondent returned only the answer sheet leaving information written on the survey instrument itself unavailable--the coded information, however, was retained with the other data. Due to the missing information some data totals will equal less than 51.

For each demographic survey item, the number and proportion of observations are shown in Appendix D. Selected statistics are presented here for convenience. Of the total returns, the percentage of respondents replying to each survey statement/question is given in parentheses. In the Tables 4, 5, 6, 7, and 8, the demographic information is described for those respondents who met the criteria for the survey. The Appendix D also describes the demographic data for: enlisted and officer AFSC; for respondent's time in position; and respectively, experience with the Mechanical, Pneudraulics, and Power, Refrigeration and Electrical shops.

There were sixteen (31 percent) respondents who had no direct involvement with E-lab prior to September 1989, were not currently involved with E-lab or had no experience with E-lab at all. Tables 9 and 10 show the experience respondents had with the SAC program. These respondents were asked to skip to the written responses. Of the fifty-one returns, thirty-five (69 percent) provided coded responses to statements twelve to twenty-six. Total responses and percentages per statement/question are presented. In some percentages, figures were rounded to the nearest whole number. The respondent data is analyzed below and is also listed in Appendix C.

Opinions Results. Responses grouped under the new variables: program, elements, and impact were used to answer the Research objective questions.

TABLE 4

Response Variable:
Years of Total Service with the Government (17)

Year Group:	0-4	5-8	9-12	13 or more
Respondents:	0	3	14	34
Percentage: (100.0% responding)	0.0	5.9	27.5	66.7

TABLE 5

Response Variable: Enlisted Respondent's Grade (17)

Enlisted:	E-3	E-4	E-5	E-6	E-7	E-8	E-9
Observations:	0	0	11	10	11	4	3
Percentage:	0.0	0.0	28.2	25.6	28.2	10.3	7.7

Total Enlisted: 38 (100.0% responding) Percentage: 76.0

TABLE 6

Response Variable: Officer Respondent's Grade (17)

Officer:	O-1	O-2	O-3	O-4	O-5	O-6
Observations:	0	0	3	5	1	3
Percentage:	0.0	0.0	25.0	41.7	8.3	25.0

Total Officer: 12 (100.0% responding) Percentage: 24.0

TABLE 7

Response Variable: Wing Respondent Stationed (17)

Wing:	I	II	III	IV	V	VI	0
Observations:	7	8	9	10	7	8	2
Percentage: (100.0% responding)	13.7	15.7	17.6	19.6	13.7	15.7	3.9

TABLE 8

Response Variable:
Respondent's Experience with the Electronics Lab
(Indicated by the length of time
supervised or worked in) (17)

Months:	0	1-6	7-12	13-24	25 or more
Observations:	14	4	2	10	20
Percentage: (98.0% responding)	28.0	8.0	4.0	20.0	40.0

TABLE 9

Response Variable:
Respondents Associated (or directly involved) with the
Electronics Laboratory Maintenance Activities prior to
September 1989 (Date two-level implementation began). (17)

Response:	YES	NO
Observations:	33	17
Percentage: (98.0% responding)	66.0	34.0

Research Objective One was determined to be beyond the scope of this study and therefore was not pursued. Research Objective Five was not addressed due to the weak results of the reliability analysis. The factor analysis, in its attempt to find reliable variable relationships, eliminated the data intended to support Research Objective Five and therefor was left for future research.

The following analysis used the new variable groupings (Table 3) to answer the research objective questions. The new variables use several survey statements together to assess the subject of that variable. Each grouping combines its constituent statements and in the process creates a new observations scale. Each statement has an observation

TABLE 10

Response Variable:
Respondents Currently Associated (or directly involved) with the Electronics Laboratory Maintenance Activities (including scheduling, training, evaluating, etc.)? (17)

Response:	YES	NO
Observations:	34	16
Percentage: (98.0% responding)	68.0	32.0

scale with five possible observations Disagree Strongly, Disagree, Neutral, Agree and Agree Strongly. The new variables will use the same Likert Scale however with the number of gradients equal to ten for the variable with two

statements and twenty for the variable with four statements included. The result is a finer gradient of observations than that found in a single statement's responses scale.

Research Objective One

(Of those areas considered and selected for conversion, what types and levels of maintenance have been applied to ICBM maintenance operations under the Program Document 90-4?) To determine what types and levels of maintenance were applied to ICBM maintenance would entail an inappropriate and lengthy procedure in the survey instrument. The intent of this survey was to ascertain the opinion of personnel on the implementation of the two-levels of maintenance program. The type and level of maintenance may be best obtained from several "expert" sources rather than from multiple wings, etc. Respondents, by virtue of their assignment, may only be privy to partial information on types and levels specific to the wing or squadron.

Research Objective Two

(What have been the results of implementing two-level maintenance at ICBM Minuteman II, III and Peacekeeper units?) To determine the results, respondents were asked to agree or disagree with several statements concerning the implementation of the two-levels of maintenance. These statements are captured in the new variables: PROGRAM and ELEMENTS presented below with their corresponding

frequencies and percentages. Percentages are round to nearest whole number.

Variable: PROGRAM. This variable describes the statements that deal with active participation in the policy making and administration of the two-levels of maintenance program. These statements had a weak correlation index: alpha equals 0.53 (see Appendix F). Responses to the following two survey statements make up the PROGRAM variable data and are shown in Table 11.

> Statement Number 12. My office has been actively involved with the planning stages of implementing two-levels of maintenance in ICBMs.

> Statement Number 13. My office has been actively involved in the implementation of two-levels of maintenance in ICBMs.

Analysis. In the analysis of the PROGRAM variable, Figure 4. further describes the response tendency in terms of categories of respondents. The tendency of the respondent was to remain neutral with a slight attitude toward disagreement. The senior-level enlisted personnel tended to disagree more than the middle-level Non-Commissioned Officers on the statements concerning their active involvement in the program from the beginning (see Figure 4). Other statistical tests showed respondents, as a group, remaining neutral to whether they actively participated or not. The longer the respondent's service time, a tendency showed the respondent was less actively involved with planning and implementing of the program (see

TABLE 11

Survey Response Data: PROGRAM Variable (17)

	DISAGREE STRONGLY		DISAGREE		NEUTRAL		STRONGLY AGREE		AGREE
Scale:	2	3	4	5	6	7	8	9	10
Observations:	3	1	4	7	6	5	5	3	1
Percentage:	8.6	2.9	11.4	20.0	17.1	14.3	14.3	8.6	2.9

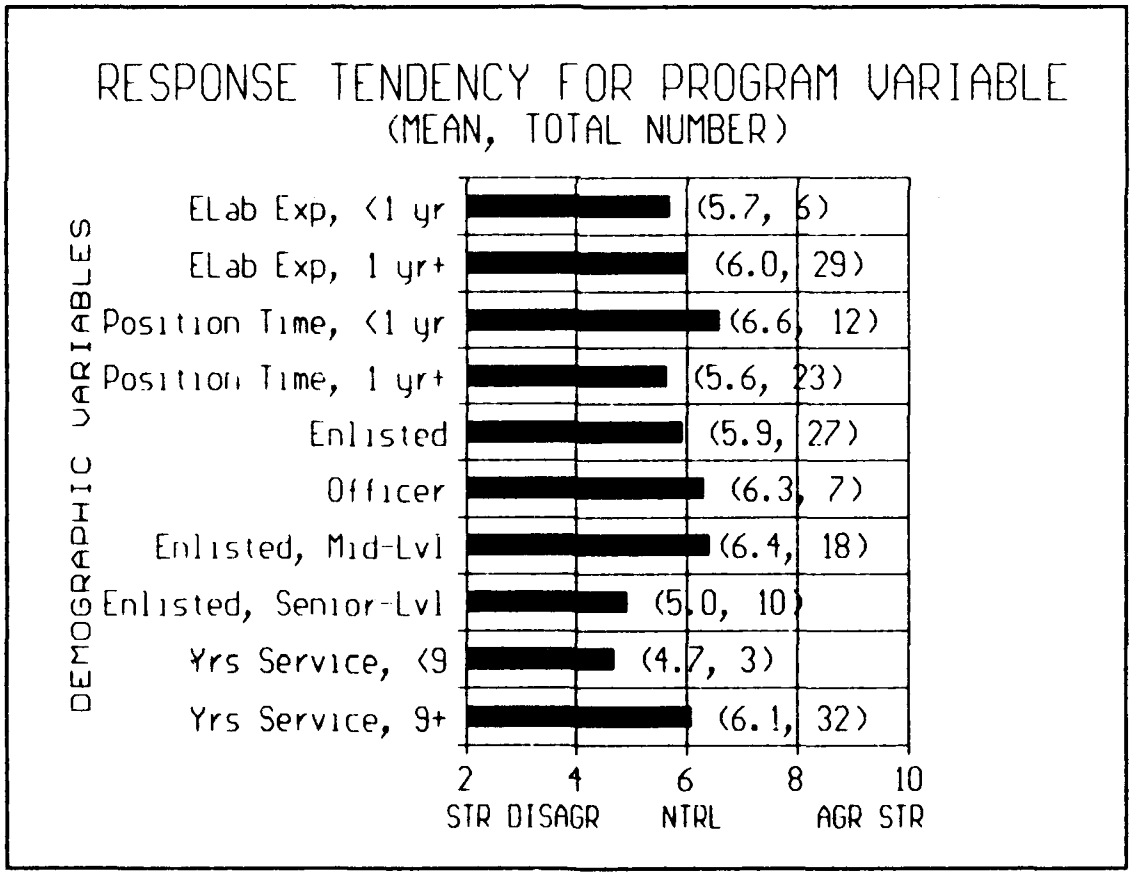

Figure 4. Central Tendency Measures - PROGRAM Variable (17)

Figure 4). The individual item data indicated most were not involved in the planning but were involved in the implementation.

Variable: ELEMENT. The statements involving seldom performed (one to two times per year) tasks, technician proficiency, dedicated equipment and level of maintenance were used to formulate this variable named ELEMENT. The common theme follows from a larger set of criteria used to determine which tasks are suitable for programming into two-levels of maintenance. Responses to the following four survey statements make up the ELEMENT variable data; they are shown in Table 12. Figure 5 describes

> Statement Number 15. Of the tasks transferred, all tasks were seldom performed tasks.
>
> Statement Number 16. Of the tasks transferred, all tasks were associated with a low level of technician proficiency.
>
> Statement Number 21. Of the tasks transferred, each had its own dedicated (unique to the component/task) test/support equipment.
>
> Statement Number 23. Of the tasks transferred, the maintenance performed involved significant (more than simply minor) maintenance action(s).

The statements together have a moderate correlation index: alpha equals 0.75 (see Appendix F).

Analysis. In the ELEMENT variable analysis, all demographic variables, with few exceptions, showed slight tendency toward disagreement with the element variable as a whole. Those respondents with longer E-Lab experience

tended to disagree more than those with less than one year of E-lab experience (see Figure 5). Those respondents who have served the government least, tended to disagree more. Most respondents, according to item data, tended to not believe that all tasks were: of the seldom performed nature, of a low technician proficiency, nor had its own dedicated equipment. On the contrary, the respondents did tend to agree that the maintenance performed was significant (more than simply minor). To determine this mission readiness aspect, the respondents did tend to agree that the maintenance performed was not minor maintenance, but significant maintenance. The next two research objectives were responded to by the new variable IMPACT.

Research Objective Three

(Was there a change in the mission readiness level (alert rate)? If so, how has the level (alert rate) changed?)

Research Objective Four

(Was there a change in the availability of mission support equipment (MSE)? If so, how has the level changed?)

Variable: IMPACT. This variable, named IMPACT, concerned statements measuring the perception of the program's impact on the alert rate and spares availability. The respondents were asked to agree or disagree. The

TABLE 12

Survey Response Data: ELEMENT Variable (17)

	DISAGREE STRONGLY				DISAGREE				NEUTRAL				STRONGLY AGREE				AGREE
Scale:	4	.	6	.	8	.	10	.	12	.	14	.	16	.	18	.	20
Observations:	2	0	3	2	6	5	1	4	5	2	2	1	0	0	1	0	1
Percentage:	6	0	9	6	17	14	3	11	14	6	6	3	0	0	3	0	3

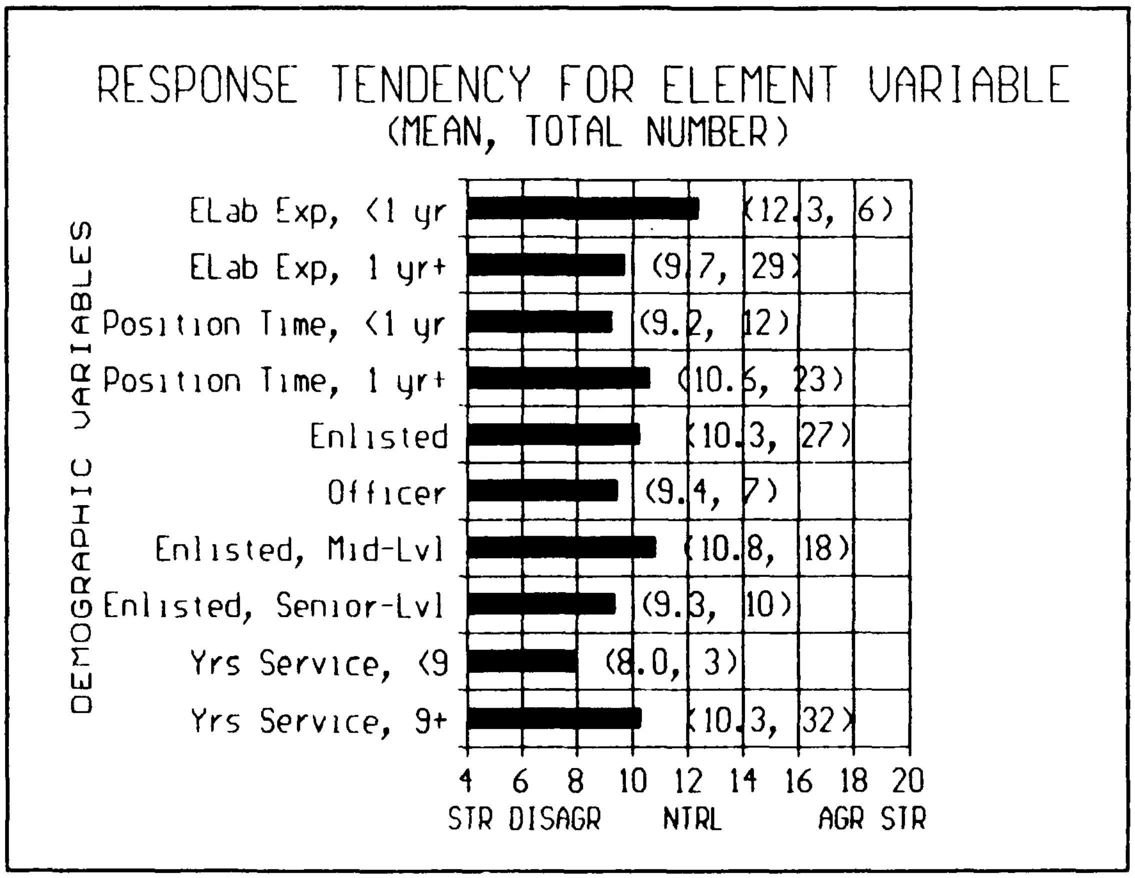

Figure 5. Central Tendency Measures - ELEMENT Variable (17)

statements' observations and percentages are presented below. The percentages do not total 100 percent due to rounding to the nearest whole number. The statements have a strong correlation index: alpha equals 0.95. Responses to the following two survey statements makeup the IMPACT variable data in Table 13.

> Statement Number 18: The transfer of maintenance tasks to two-levels has not adversely impacted the wing's weapon system alert rate.

> Statement Number 19: As a result of the transfer of maintenance tasks, the spares availability has not adversely affected the maintenance operations at this wing.

Analysis. The demographic variables tend to show respondents agreed that no adverse effect was seen due to the implementation of the two-levels of maintenance program. In Figure 6, the central tendency measures are depicted. The data supporting these findings have been determined to be reverse scored and treated as such in this analysis. The respondents who hold higher-level or staff supervisory positions show a tendency to agree more than those who do not; though the difference was not statistically significant. Individual item data show that respondents believe alert rates were not impacted due to the program. How much of an impact is unknown. Most respondents also believed that the two-level program did not adversely affect maintenance operations.

TABLE 13

Survey Response Data: IMPACT Variable (17)

	DISAGREE STRONGLY		DISAGREE		NEUTRAL		STRONGLY AGREE		AGREE
Scale:	2	.	4	.	6	.	8	.	10
Observations:	0	0	7	3	5	2	5	6	7
Percentage:	0	0	20	9	14	6	14	17	20

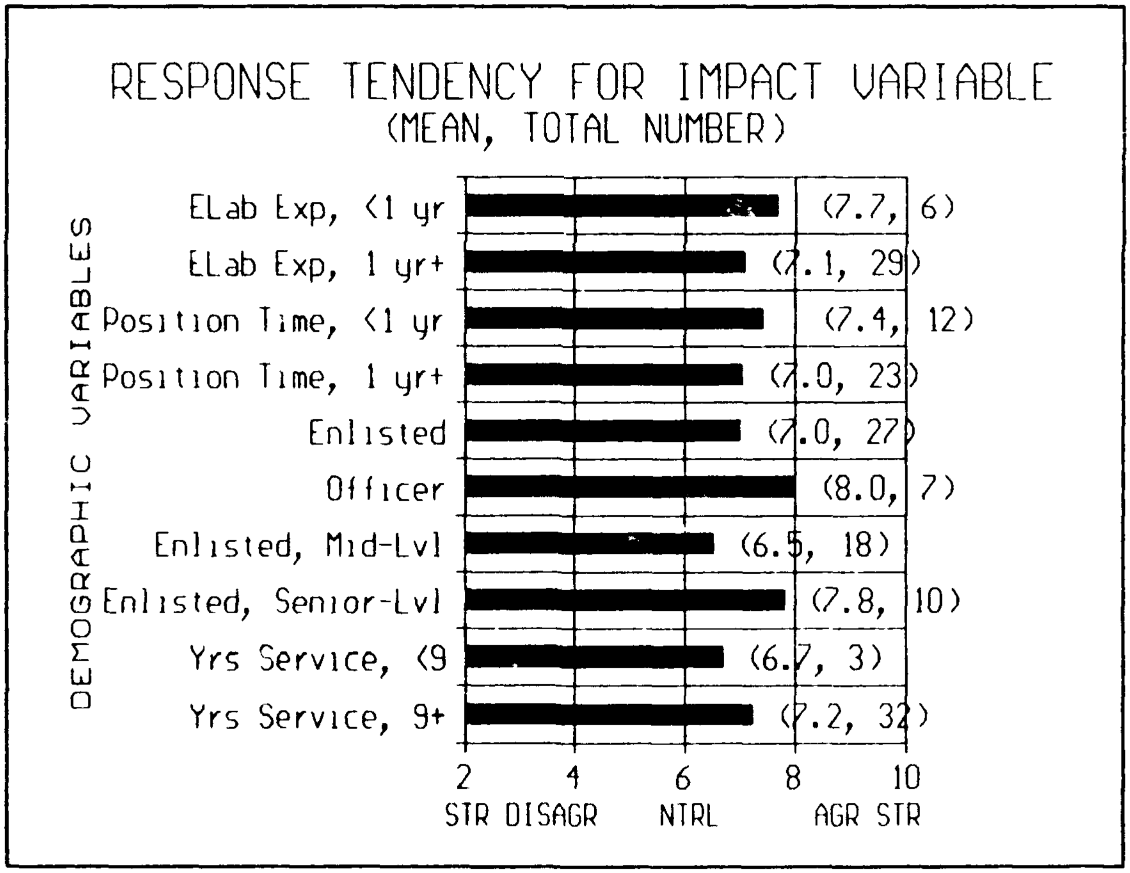

Figure 6. Central Tendency Measures - IMPACT Variable (17)

Research Objective Five

(How has resource, manpower and equipment, utilization improved as a result of switching from three-level to two-levels of maintenance?) Due to the reliability of the results the data was determined to be insufficient to properly and confidently answer this question.

Research Objective Six

(Of those maintenance task areas not-selected for conversion at this time, which have the potential for change from a three-level to a two-level maintenance scheme?) To determine the answer to objective six, two open-ended questions were offered to which the respondents could freely comment. Of the ninety-eight percent of the respondents, only forty-six percent commented on the "top five" maintenance areas with potential for inclusion in a two-levels of maintenance concept. On the "comments" question, sixty-eight percent replied with valuable commentary to the subject of implementing two-levels of maintenance in ICBMs. The respondents were asked to respond with their written comments; the results are listed in Tables 14 and 15. A complete but edited summary of the comments is provided in Appendix C.

Analysis. The analyses of statements numbered 27 and 28 are provided below. The responses to statement number 27 were varied in suggesting that any one maintenance task may be further considered by the two-levels of maintenance

Statement Number 27: List the "top five" shop maintenance tasks that are potentially suitable for transfer under a two-level maintenance concept. Include the associated limiting factor(s) that you feel keeps the task from being transferred.

TABLE 14

Survey Response Data:
Comments on the Top
Five Shop Maintenance Tasks

Responses:	23	Non-responses:	27
Percentages: (98.0% responding)	46.0%		54.0%

Statement Number 28: Provide comments you think would be beneficial to the implementation of two-levels of maintenance in ICBMs.

TABLE 15

Survey Response Data:
Comments on the Implementation
of Two-Level Maintenance

Responses:	34	Non-responses:	16
Percentages: (98.0% responding)	68.0%		32.0%

program. The most numerous items pointed to were the Minuteman Power Processor (MPP), various electronic drawers, the Alarm Monitor Panel, the UHF Radio Receiver Drawer and many others. The Appendix F lists the edited written

responses to statement 27. Most responses failed to associate a limiting factor that kept the item from being programmed to a two level routine. The majority of responses alluded to potential E-Lab tasks only. No tasks were specifically identified in the shops of Mechanical, Pneudraulics or Power, Refrigeration and Electric.

In the analysis of the written responses to survey statement number 28, the majority of respondents commented on the suitability of this maintenance program. Appendix F presents the responses in an edited format for conciseness and clarity. There were several responses that warranted recognition and further discussion.

The most prevalent reply concerned spares availability and reflected upon the impact of this new program on that level and the individual unit's mission effectiveness. Spare components or parts topped the list of most frequent comments as did concern of lengthy repair pipeline cycle times. Consideration of sufficiency of spare components was apparently wanting as many units required special attention to their parts replacement capability to keep sites on alert. This attention involved the waiver of depot repair by the MAJCOM so that units could on their own fulfill their workload requirements without the lengthy base-depot-base pipeline times. Numerous other comments given ranged from the "What were the goals of the SAC program?" to "Where that unit experienced no significant effects from the two-level program implementation (a positive comment)." The unit with

no significant effects attributed the minimal effects to the low-failure nature of the transferred tasks.

Summary

Overall, the respondents, as a whole, believe that the program implementing two-levels of maintenance in ICBMs has been more of a problem than a help. Some are adamantly against the change while others wish for clearer direction and guidance to help develop the program. Conclusions and recommendations are discussed in Chapter V.

V. Conclusions and Recommendations

Overview

Chapter V presents the conclusions and recommendations identified through this study. The results of the study are statistically limited to only the reliable variables--that is the survey statements identified in Table 3, Chapter IV. This study makes inferences about the perceptions of the missile maintenance personnel surveyed on the implementation of two-levels of maintenance in ICBMs. The significance of the survey results is discussed using logical inferences to address each research objective.

Conclusions

The conclusions for the research objective questions 2, 4, and 6 are provided below. The reliable variables are identified that answer research objective questions and a description of their limitations are also defined in Chapter IV. These <u>interpretable</u> variables are selected survey statements that, at the very least, make statistical sense--that is, the variable's responses tend to follow a common theme. This subset of the original survey variable design is identified largely due to the small number of usable returns (thirty-five). Research objective questions numbers 1, 3, and 5 are left for future study.

From the outset, the focus of the Minuteman intercontinental ballistic missile weapon system was on work force savings. After more than twenty-five years of being on operational alert, one would expect to have a "lean" system organized in such a refined way to preclude further significant "streamlining."

Base repair capacity apparently still exists for some items transferred under the SAC two-level maintenance program. If the SAC program was to be successful on a large scale, the intermediate-level maintenance capacity would truly be transferred. In missiles however, the suitability of changing to two-levels of maintenance is meeting with problems as similarly found in previous studies on two-levels of maintenance.

The costs of maintenance operations is a significant consideration when attempting introduce and run a two-levels of maintenance concept during a system's "operations phase." From most accounts of managing maintenance concepts, the early stage of weapon system development is the best time for implementing two-levels of maintenance. In practice, Minuteman program managers had exactly this idea from the beginning. Trying to implement two-levels of maintenance now in a system already mature clearly is having some difficulty in realizing more benefits than costs of implementing. In a system that has not the (large) scale as some aircraft programs, the opportunity to claim cost savings appears to be negligible. This was the expectation

stated in the Strategic Air Command (draft) Program Document 90-4. The conclusions to research objective statements two, four, and six follow.

<u>Research Objective Two</u>. (What have been the results of implementing two-level maintenance at ICBM Minuteman II, III, and Peacekeeper units?) The statistical analysis provided a logical grouping of survey items that gave no conclusive results or common response theme when the responses were grouped as a whole. When the survey data was regrouped (as described in Chapter IV), there is an apparent indication that most respondents' offices participated in the maintenance program's implementation but not in the program's planning.

Most respondents believed that the tasks transferred under the SAC program were not fitting the description of seldom performed (one to two times per year) tasks, low proficiency rate tasks or tasks requiring equipment unique to the task. The information, if any, on the mean time between failure (MTBF) rates or cost-benefit savings rates was not addressed in this study. Such quantitative data would shed a more decisive light on which tasks are eligible for reprogramming under the maintenance concept.

<u>Research Objective Four</u>. (Was there a change in the availability of mission support equipment (MSE)?) The statistical analysis showed respondents as agreeing with the statement that there was no adverse impact on mission alert rates. This is as SAC program managers had predicted. The

analysis also showed respondents as agreeing there was no adverse impact on spares availability. However, this directly contradicts written comments that prominently complained about spares availability and component repair turn around times. The reverse coding may have had a role to play in the misinterpretation of this spares availability data.

Research Objective Six. (Of those maintenance task areas not selected for conversion at this time, which have the potential for change from a three-level to a two-level maintenance scheme?) A variety of potentially reprogrammable maintenance tasks were identified by the written responses. The study's data is solely based upon opinion and contains virtually no historical or cost-benefit information. Therefore, it would be inappropriate to use this data and results alone to substantiate a decision on maintenance task reprogramming. A cost-benefit and historical data analysis is necessary for any meaningful commander decisions to reprogram a maintenance task from a three-level to a two-level maintenance routine.

Written responses from the general comments statement (survey statement number 28), are listed in detail in Appendix C. The concerns of the respondents point to what should and what should not be done with the two-levels of maintenance program. Most people responding indicated that they are disappointed from the program's benefit to maintenance operations.

Recommendations

The two of most prominent issues identified from the study are: First, concern over the increased spares requirements due to reprogramming of maintenance responsibilities. The SAC program raised the issue: that without provisioning for more spares to meet the maintenance workload the program only goes part way. Second, concern over the cost versus benefit of injecting repairable parts into the maintenance repair pipeline when there is no visible added benefit.

The following recommendations are made. First, regarding any future ICBM force restructuring, consider whether the decommissioning of systems (i.e., Minuteman II, etc.) would provide needed ICBM spares for the existing maintenance reparables pipeline. The potential for spares availability would increase when systems are decommissioned. The intermediate-level shop repair capability, when relocated to the ALC, needs more spares in its pipeline to and from the operating unit. For any urgently needed items, the spares' availability should include a "next day delivery" type service.

Second, recommend that tasks identified for reprogramming be analyzed for their contribution to cost-benefit analysis. The main objective would be to save on major costs like equipment sourcing, etc. and not just on manpower costs alone. Remembering the PACAF Logistics Support Center existed primarily for improved combat

flexibility, the decision to reprogram, by component, to two-levels of maintenance should consider quantitative analyses. The PLSC did not consider manpower savings as its reason for existence. A quantitative analysis should find a priority of eligible maintenance tasks that would provide a general cost savings when reprogrammed.

Appendix A: Program Document 90-4

PROGRAM DOCUMENT

90-4

IMPLEMENTING TWO LEVELS

OF

MAINTENANCE IN ICBMs

1 DECEMBER 1989

LGB

Program Plan 90-4, Implementing of Two Levels of Maintenance in Missiles.

See Distribution

PURPOSE

1. This plan provides guidance necessary to implement two levels of maintenance in ICBMs. It entails relocating some intermediate-level maintenance (ILM) performed by the missile Electronics Laboratory to AFLC and the remaining tasks to the unit organizational-level maintenance (OLM) areas. This plan can also serve to be used in a regional or "Queen Bee"-type operation. It can also serve as a guide in future intermediate-level transfers. Organizational restructuring and realigning will be required if two levels of maintenance is fully implemented. Further, organizational and procedural changes within transportation and supply are required and addressed. Manpower authorizations will be deleted or realigned throughout the life of this plan.

AUTHORITY

2. This action was approved by the Air Force Chief of Staff on 1 Aug 89.

a. Two levels of maintenance will be implemented across the Air Force.

b. SAC directed to lead the effort.

c. Some ILM will be transferred to an Air Logistics Center (ALC).

(1) Ogden ALC has been the prime depot for missiles and as such is logically the primary ALC for this program.

(2) The missile Electronics Laboratory is the most diverse of all ILM organizations at a missile unit and is the most logical place to begin. Other shops, the Mechanical, Power, Refrigeration, and Electric, and Pneudraulics shops will also be addressed at later dates.

(3) Those ILM tasks transferred to the ALC will be assimilated into depot-level maintenance (DLM) over time.

(4) Remaining ILM tasks will be transferred to organizational level maintenance or other organizations or

avenues e.g. contract, test, measurement, and diagnostics equipment, communications, etc.

d. Weapon system impact will be kept to an absolute minimum.

e. Economics must be realized.

f. If a regional or "Queen Bee"-type organization is determined to be more suitable or desirable, this plan will suffice in determining proper actions to undertake however minor adjustments will be necessary.

PRELIMINARY STAFF CONSIDERATIONS

3. Maintenance Concept of Operations: In an effort to streamline the maintenance capability of missile maintenance organizations and achieve economies by reducing manpower, equipment, facilities, and parts, intermediate-level maintenance will cease to exist as it is currently known in themissile Electronics Laboratory for the purposes of this plan. The specific maintenance tasks performed by the Electronics Laboratories vary from unit to unit due to the unique characteristics of the MINUTEMAN II, MINUTEMAN III, and PEACEKEEPER weapon systems and due to modifications and programs (ERCS) each unit performs. Associated with each of thise characteristics is varying types and amounts of support and test equipment. It is therefore incumbent upon the HQ SAC/LGB staff and tasks organizations to expand general taskings to encompass all six missile units and the 394th Intercontinental Ballistic Missile Test Missile Squadron at Vandenberg AFB Ca. An initial review of Job Qualification Standard (JQS) tasks has been undertaken to determine which tasks will be transferred to OLM and DLM. This initial review revealed that a phased approach to transition is best. Factors bearing on this decision are nuclear certification requirements; addressing requirements, commonly known as "strapping;" and unique test equipment based on aforementioned programs/modifications associated with particular weapon systems. Some of these pieces of test equipment are "one of a kind," with little, if any formal depot support. During the initial review of JQS tasks, it became apparent that some tasks can be readily transferred to DLM without any impact on mission accomplishment but at the same time, little if any, reduction in manpower at the "I" level nor increase, if any, at the "D" leel. Furthermore, weapon system impact was determined to be nil. These tasks were/are being transferred to DLM. Some savings are being/will be achieved, however, in that specialized test equipment associated with these tasks will no longer exist at the units, saving utility costs, training manhours, tester maintenance hours and parts, and the turmoil associated with

maintaining proficiency on seldom-performed (1-2 times a year) tasks. Some non-quantifiable savings are also expected such as scheduling, paperwork processing, etc.

a. The phased approach to implementation will follow the following general guidance:

Phase I - Tasks Readily Transferred
-- JQS Review
-- Hardware Repair Changes
-- Technical Order Changes

Phase II - Sister Shop Changes
-- Similar Requirements/Changes

Phase III - E-35 Test Bench Certification
-- Further Transits Allowed

Phase IV - Nuclear Certification Requirements Approved
-- Allows other tasks to be transferred

Phase V - Addressing (Strapping) Problems Overcome
-- Allows other tasks to be transferred

Phase VI - New/Replacement items brought on-board with Nuclear Certified built in test (BIT)/built in test equipment (BITE) maintenance support equipment (MSE) to allow OLM/DLM transition.

b. A pilot unit will be established during the transition phases. During phases I and II no pilot unit is needed as no loss in capability is anticipated. Transition to phase III however, will require a pilot or test unit be established with a support unit or units identified to support the pilot or test unit during phase III implementation. The pilot unit may be used throughout all succeeding phases or "Sister shop" phases or other units may be selected to ease "the pain." The selected unit will be determined using suportability criteria during the transition phase (Phase III), on-going and programmed modifications which may be impacted or will impact the pilot program and other quantifiable and non-quantifiable factors.

c. Some TDY and/or PCS moves are anticipated initially. Once a mixed cadre of highly qualified and career-oriented technicians is in place either at OO-ALC or a regional location, few PCS moves are anticipated. Remaining technicicans will be handled through attrition and

PCA moves. HQ SAC/LGB/DPX/XPM/LGS/LGT and the NAF staffs, as appropriate, will establish a projected wing phase-in schedule for future transition. Again, each unit must be thoroughly scrutinized to prevent loss of maintenance capability.

d. All action taken in connection with this plan must be accomplished on a least-cost basis with the objective of realizing the maximum possible savings.

e. The two levels of maintenance concept is designed to improve maintenance efficiency and determine ways to reduce the operating costs of manpower and equipment without mission degradation. Life cycle costs [are] the final determining factor however early costs coupled with budget reductions cannot be ignored.

f. Only the Electronics Laboratory is addressed by this plan. Implementation of two levels of maintenance into other ILM organizations requires the same basic concepts developed by this plan, however specific taskings must be adjusted. Likewise adjustments must be made if a regional concept is used.

g. A reduced maintenance capability will exist in the wings; however, streamlined procedures, responsive transportation, and enhanced reliability, will allow units to meet SIOP commitments, SACR 55-7 generation requirements, and continue training programs and modifications programs.. Maintenance support during conversion of two levels of maintenance will be furnished by the wings. Prior to implementation, a thorough review of upcoming modifications, MCLs, TCTOs, and special programs/events must be undertaken to ensure minimum impact.

h. A strong interface is required among maintenance, supply and transportation to ensure expeditious shipment of components in the pipeline.

i. Transfer of ILM will have virtually no impact on unit civilian personnel. Some contractual obligations are affected, however, and will be addressed on a case by case basis.

j. Some impact on 411X0 training and pipleine students is to be considered. ATC courses need to be [scrutinized].

k. Across-the-board implementation of two levels of maintenance will entail reorganization of maintenance units.

l. Enhanced AFR 122-17, Critical Components and Certified Software Procedures, need to be approved before

Electronics Laboratory implementation can be fully implemented.

m. Based on DNS approval of certification procedures, future E-35 (Automatic Test Station) procurement/deployment may be affected.

n. Some reinvestment of potential manpower savings is needed to offset increased transportation and supply workloads.

o. Contractor and/or PMEL support may be required to accomplish some tasks normally assigned to ILM.

p. Depending on "D" to "O" transfer, and all other [permutations] of "D", "I", and "O" transfers and transfers with "O", additional technical training will be required.

q. Cannibalization documentation during test is absolutely essential to realize impact.

r. Few portable testers or BIT/BITE capability exists in missiles.

s. Future systems will be built with two-levels in mind e.g. control monitors, REACT, etc.

t. This plan is goal-oriented versus time critical.

u. During pilot or test phase, a wartime degradation cost may be established.

v. Transfer of technicians from ILM to OLM will require caution as these technicians will be noncompatible code handlers. Electronic Laboratory personnel cannot readily be transferred (PCA) to the Electro-Mechanical Shop even though they possess the same AFSC. SACR 55-56 must be followed to prevent code compromise during transistion to two levels of maintenance thereafter.

PLANNED COURSES OF ACTION

1. The DCS/Plans and Programs will:

a. Prepare Annex A to this plan (XPM).

b. Establish manpower criteria to evaluate pilot program.

c. Provide document updates as required.

d. Establish milestones for programming actions.

e. Interface with units to formulate position transfer plan.

2. The DCS/Personnel will:

a. Prepare Annext B to this plan (DPX).

b. Manage PCS actions. Assist in crosstraining actions. Interface closely with LGB/LGS/LGT for timely solution of personnel issues.

c. Work with affected units and servicing CBPOs to ensure minimum impact on mission accomplishment.

d. Track personnel issues/problems during pilot programs.

3. The DCS/Operations will:

a. Prepare Annext C to this plan (DOS).

b. Update applicable operating plans/orders, regulations, and supplements affected by this plan.

c. Interface with all other DCSs to ensure continued material support and changes to procedures affecting operations are identified and problems are solved.

d. Work with units on solving issues affected by this plan.

4. The DCS/Logistics will:

a. Prepare Annex D to this plan (LGB).

b. Be responsible for publishing, distributing, and reviewing this plan as required and update as necessary to meet the varying rquirements faced by the units.

c. Interface with the affected units and coordinate with HQ SAC DCSs to resolve issues not within the units ability to solve.

d. Adjust actions as necessary to meet program objectives.

e. Coordinate manpower issues with XPM.

f. Coordinate funding issues with LGT for material movements required by this plan.

g. Coordinate transportation requirements.

h. Interface on supply issues affecting the accomplishment of this plan.

i. Ensure appropriate agencies renegotiate, transfer, or terminate AFR 11-4, Host-Tenant Support agreements.

j. Interface with units and LGC on resolving contract issues.

k. Ensure data collection is efficiently and accurately performed as required to support this plan.

l. Interface with HQ SAC/IG and the 3901st Strategic Missile Evaluation Squadron to adjust inspection requirements.

m. Develop implementation plans adjusted to each unit's unique needs.

n. Prebrief each unit prior to implentation.

o. Develop nuclear certification procedures as needed to fully implement the goals of this program.

p. Change SACR 66-12, all volumes, and other regulations, as necessary to meet program objectives.

q. Adjust pipeline student requirements as necessary to support this plan.

r. Review all maintenance tasks for possible two levels applications.

s. Ensure future systems/modifications include two levels of maintenance in the developmental phases.

t. Provide each unit with current adjustments to the maintenance concept as they become known.

u. Conduct sites surveys as needed.

v. Program manager is HQ SAC/LGBM.

5. The DCS/Engineering and Services will:

a. Prepare Annex E to this plan.

b. Work with units in resolving facilities and utilities issues. Additional secure areas (vaults) will be needed.

c. Monitor the expenditure of funds and adjust as necessary to accomplish program objectives.

d. Perform site surveys and determine programming requirements.

e. Provide assistance in completing an environmental assessment to support this plan.

6. The DCS/Comptroller will:

a. Prepare Annex F to this plan.

b. Monitor O&M fund expenditures, and collateral expenditures. Inform appropriate agencies of concerns.

c. Assist agencies as required in determing appropriate courses of action or means to accomplish program objectives.

d. Monitor funding procedures and provide assistance as necessary.

7. Directorate of Information Management will:

a. Provide guidance as necessary to support this plan.

b. Review prposed plan and supplement as necessary.

8. The DCS/Intelligence will:

Review proposed plan and update as necessary.

9. The Directorate of Public Affairs will:

a. Become familiar with proposed plan and update as necessary.

b. Serve as the single point contact for SAC Headquarters deputates/agencies on Public Affairs matters concerning this program.

10. The Inspector General will interface with LGB on issues, procedures, and impact of program on inspection criteria. Suuplements to AFR 123-1 will be adjusted as necessary.

11. The Office of the Staff Judge Advocate will:

a. Review proposed plan and supplement as required.

b. Adivse HQ SAC staff agencies and missile units on environmental and contract laws affecting this project.

c. Review public laws and regulations as they apply to this plan.

12. The SAC Chaplain will:

a. Review proposed plan and supplement as necessary.

b. Interface with units on matters affected by this plan.

13. The DCS/Strategic Planning and Analysis will:

a. Review proposed plan and recommend changes as required.

b. Review and update applicable operating plans.

c. Interface with units to ensure local plans are updated as required.

14. The DCS/Communications Computer Systems will:

a. Prepare Annex O to this plan.

b. Review proposed plan and supplement [as] required.

c. Interface with unit's communications squadrons to ensure continued support and rectify any problems.

d. Coordinate with LGB on issues requiring resolution.

e. Review Host-Tenant Support Agreements and change as required.

15. The DCS/Security will:

a. Review proposed plan and supplement as required.

b. Prepare Annext O of this plan.

c. Review SACR 207-16 and other regulations and plans for possible impact. Resolve any conflicts with LGB and supplement as required.

16. Eighth Air Force and Fifteenth Air Force will:

a. Review proposed plan and supplement as required.

b. Interface with units during review of tasks for possible transfer.

c. Review unit plans, regulations, OIs, and suuplements to ensure they spport program objectives and to achieve efficiencies.

d. Track unit milestones and resolve conflicts. Any

actual or projected slippage will be addressed to LGB as soon as possible.

e. Interface with all HQ SAC agencies to resolve conflicts.

f. Monitor unit expenditure of funds.

g. Establish a NAF POC for the program. Provide name to LGB.

18. Missile units will:

a. Develop a plan to successfully execute this plan.

b. Establish a wing/unit POC.

c. Establish a working group to oversee the program. Forward comments, lessons learned, or proposed changes to HQ SAC/LGB without delay.

d. Interface closely with NAFs on program progress.

e. Update unit plans, regulations, OIs, and supplements as required to support this plan.

f. Supplement this plan as required.

IMPLEMENTATION AND CONTROL

19. Close coordination is required between all agencies to avoid duplication or omission of essential operations.

20. Units should submit reports through the NAFs to HQ SAC/LGB. Actions which will not be accomplished as scheduled will be forwarded to HQ SAC/LGB as soon as possible for resolution.

Report Format: Status of Time-Phased Actions.

1. Action.

2. Status.

3. As of date.

4. Estimated completion date.

5. Impact as perceived by unit on other agencies/actions.

6. Reason for delay.

7. Corrective actions.

8. Outside assistance needed.

9. POC, if other than unit POC.

21. HQ SAC functional OPRs listed in paragraph 22 will monitor required actions and report any actual or forecast slippage to the program manager. Forward all correspondence to the appropriate OPR. HQ SAC/LGB will be an addressee. Units will submit all correspondence through appropriate NAF.

22. Offices of Primary Responsibility (OPRs)

DUE TO PRIVACY ACT GUIDANCE OPR INFORMATION HAS BEEN LEFT OUT

CONTACT HQ SAC/LGBM FOR MORE INFORMATION

TIME	
- Establish Concept of Operation	LGBM
- Go Ahead Date	
- JQS Review	LGBM/ALC/Units
- Finalize Tasks	LGBM/ALC
- Select Test Unit	LGBM
- Select Support Unit	LGBM
- Establish Unit POCS	Unit/LGBM
- Brief Test Unit	LGBM
- Survey Test Unit	LGS/LGT/DEL
- Survey Support Unit	LGS/LGT/DEL
- Survey OO-ALC	LGS/LGT/DEL
- Review Backorder Requisitions	LGB/Unit
- Adjust Transportation Schedule	LGT
-- WIP Cancel Date	LGT
-- Test Start Date	LGT
- Develop Training Plans	LGS/LGT/LGBM
- FUB Approval	Unit/ALC/DEL
- Conduct Training	LGS/LGT/LGBM

- Establish Work in Progress (WIP)	____
- RADS Survey	LGT
- Shipping Container Survey	LGT
- Reuseable Containers Survey	LGS/LGT
- Establish AFLMC Data Needs	LGY
- Develop Data Collection Plan	LGBM/LGY
- Train Personnel on Data Collection	All
- Replenish Bench Stocks	LGS
- Bench Stocks Moved	LGT
- Establish TODO Accounts	ALC
- Establish Classified Accounts	ALC
- Es ablish Security Procedures	ALC/Unit
- Establish Housing/Transportation Requirements	ALC/Unit
- Prepare Annexes to Implementation Plan	All
- Prepare Supplement to AFM 67-1	LGS
- Prepare/Distribute Changes to SACR 66-12, Vol I-VI	LGBA/Unit
- Prepare Changes to OPLANS/OPORDS as Required	DOMM/Unit
- Prepare Changes to OIs/Regulations/ Supplements to Support Plan	Unit
- Change Lesson Plans	Unit
- Manpower Review	XPM
- Manpower Documents Updated	XPM
- Transfer Manpower Requirements to LGS/LGT	XPM
- IG Procedural Changes Developed	IGWM/LGBA
- 3901 SMES Procedural Changes Developed	3901/LGBA

- SACR 207-16 Changes Developed	SPOX
- Table of Allowance Changes Developed	LGS/Unit
- Transportation Requirements Established	LGT
- Supply Data Banks Sent to AFLMC	LGY
- Review Host-Tenant Support Agreements	Unit/LGBM
- Review Impact on ATC Student Pipeline	TTGT/LGBA
- Review Inspection/Calibration Requirements	Unit/ALC
- Review Publication Accounts	Unit/ALC
- Review DIFM Assets	LGS
- Review ITK, CIK, Special Tools	Unit/ALC
- Review Unit TRNS	LGS
- Review Evaluation Program Requirements	Unit
- Review Task Coverage for Remaining ILM	Unit
- Prepare Finance Support	ALC/Unit
- Prepare Travel Orders	Unit
- Personnel Depart TDY or PCS	Unit
- Test Begin	All
- Funds Transfer	ACBO
- Adjust Future Budget Requests	Unit/ALC/ACBO
- Transfer Security/PRP Responsibilities	Unit/ALC
- SACMET Involvement	XPM
- Procure Portable MSE	ALC/LGBM
- Work Communications Support	SCL
- Work Computer Support	SCL/LGBA
- Midcourse Review	All
- Develop Nuclear Certification Procedures	LGBM/IGF

- Request Nuclear Certification Procedures by Reviewed by DNS	LGBM/IGF
- TDI Certification	ALC
- Phase I Tasks Transfer	ALC/Unit/LGBM
- Phase II Tasks Transfer	ALC/Unit/LGBM
- Phase III Tasks Transfer	ALC/Unit/LGBM
- Phase IV Tasks Transfer	ALC/Unit/LGBM
- Phase V Tasks Transfer	ALC/Unit/LGBM
- Phase VI Tasks Transfer	ALC/Unit/LGBM
- Other Tasks Transferred to OLM	All
- Dismantle and Package Parts and Equipment to be Transferred	LGBM/LGS/LGT/Unit
- Parts and Equipment Arrival	ALC/LGT
- Inventory Parts and Equipment	ALC/LGT
- Equipment on Line	ALC/DEL
- Review Potential Personnel to PCS to TDY	Unit
- Review OJT/Promotion Testing/CDC Requirements	Unit

Appendix B: Research Questionnaire

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS STRATEGIC AIR COMMAND
OFFUTT AIR FORCE BASE, NEBRASKA 68113 5001

1 9 APR 1991

REPLY TO ATTN OF: LGBM

SUBJECT: Research Questionnaire, AF SCN 91-27

TO

1. The LGBM is sponsoring Captain Alan Russell's, AFIT/LSG, research on the perceptions of missile maintenance personnel on the Alternatives to Intermediate-level Maintenance (AIM) program otherwise known as two-levels of maintenance. The purpose of this research is two-fold. First, to determine how the results of implementing two-levels of maintenance in the E-Lab shop are perceived at base level. Second, to determine where potential exists for future implementation of two-levels of maintenance.

2. As a missile maintenance specialist and part of the wing maintenance effort responsible for the accomplishment of wing maintenance objectives, your response is vital in determining the suitability of two-levels of maintenance in ICBMs.

3. Individual responses will be combined with other responses and treated confidentially. Your participation in this research is voluntary, but we would certainly appreciate your help. Any questions concerning this questionnaire should be directed to Captain Alan Russell, AFIT/LSG, by leaving your message and contact at (513) 235-0809 or DSN 785-8989.

4. Please take the time to complete the attached questionnaire and return it in the attached envelope within 10 days of receipt.

Michael W. Sayer

MICHAEL W. SAYER, Lt Col, USAF
Chief, ICBM Maintenance Division
Directorate of Missile Maintenance

4 Atch
1. AFIT/LSG Ltr
2. Questionnaire
3. Answer Sheet
4. Envelope

Peace . . . is our Profession

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

REPLY TO ATTN OF: AFIT/LSG (Capt Russell, AV 785-8989)

SUBJECT: Research Questionnaire (AF SCN 91-27)

TO: Respondent

PLEASE NOTE: The reader should hold the the position/AFSC combination listed in paragraph 2. If not, please give the letter and questionnaire package to the addressee (or representative) with the requested experience per paragraph 2.

1. The questionnaire is part of research to determine your perception of Two-Levels of Maintenance, in the shops of E-Lab, Mechanical, Pneudraulics and/or PREL. Specifically, the research concerns the shift of maintenance responsibility for some E-Lab tasks to depot level repair (aka, organizational and depot levels only). Also, the study will determine what other maintenance tasks (not only in E-Lab) that may be suitable for future implementation into two-levels of maintenance.

2. The questionnaire is intended for <u>one</u> representative of either AFSC identified that is assigned to each of the following areas: MB (3196 or 41100), MBM (3116 or 41199), MBMJ (3124, 41199 or Shops Scheduler), MBMS (3124 or 41199), MBQ (3116 or 41100), MBQ (411X0 E-Lab Evaluator), FMMS/CC (A3116), FMMS/MBA (3116, 41199 or 41100), MBAF (3124 or 41199), MBAS (3124 or 41199), MBASE (41170 Shop Chief), MBASE (411X0 Shop Scheduler), MBASE (411X0 Shop Trainer).

3. If there are any questions concerning this questionnaire, please contact me by leaving your name and AUTOVON number at AV 785-8989. Thank you for your time.

Alan H. Russell

ALAN H. RUSSELL, Captain, USAF
Air Force Institute of Technology
Graduate Program of Systems Management

Other Atchs
Questionnaire
Answer Sheet
Return envelope

STRENGTH THROUGH KNOWLEDGE

QUESTIONNAIRE ON TWO-LEVELS OF MAINTENANCE

The following questions and statements are designed to collect information about your experience with the subject matter. Please respond by finding the number in the parentheses next to your answer, (1) up to (7), and mark the answer sheet accordingly, i.e., E-4 or O-2 = (2); Minot AFB, Wing III = (3). For your written responses, space is provided on the survey.

Demography Information

1. Your number of years of total service with the government is

0-4 (1) 5-8 (2) 9-12 (3) 13 or more (4)

2. Your grade is:

	E-3	E-4	E-5	E-6	E-7	E-8	E-9
Enlisted	E-3	E-4	E-5	E-6	E-7	E-8	E-9
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Officer	O-1	O-2	O-3	O-4	O-5	O-6	

3. Wing Stationed:

I	II	III	IV	V	VI	0
(1)	(2)	(3)	(4)	(5)	(6)	(7)

4. Present duty position and Primary AFSC (e.g., MB 3196; Sq/CC, Div. Chief 3116/41100/41199; Branch Chief 3124/41100/41199; E-Lab Shop Chief, Shop Scheduler and AFSC, 41170, 41150,etc.)

Position:____AFSC:______

5. The time (in months) you have held the present position is:

0-6 (1) 7-12 (2) 13-24 (3) 25 or more (4)

For the purposes of this survey the term "shop" refers to the Electronics Lab (E-lab), Mechanical Shop, Pneudraulics Shop, Power, Refrigeration and Electrical (PREL) Shop. Also, the term "task(s)" refers to E-Lab maintenance tasks transferred under the SAC program "Implementing Two-levels of Maintenance in ICBMs".

Indicate your experience with the following shop(s) by the length of time you have supervised or worked in the respective shop(s).

Shop	Number Months Experience				
	(1)	(2)	(3)	(4)	(5)
6. Electronics Lab	0	1-6	7-12	13-24	25 or more
7. Mechanical Lab	0	1-6	7-12	13-24	25 or more
8. Pneudraulics Shop	0	1-6	7-12	13-24	25 or more
9. Power, Refrigeration & Electrical shop	0	1-6	7-12	13-24	25 or more

10. Have you been associated (directly involved) with the Electronics Laboratory maintenance activities prior to September 1989 (date two-level implementation began).

Yes (1) No (2)

11. Are you currently associated (directly involved) with the Electronics Laboratory maintenance activities (including scheduling, training, evaluating, etc.)?

Yes (1) No (2)

NOTE: If you answered "Yes" to questions 10 or 11 please continue with the survey. If you answered "No" to questions 10 or 11 please skip to question number 27 and continue with the survey. If you answered "zero" months experience for questions 6, 7, 8, and 9, please return your survey to the address listed at the end of this survey. Thank you for your time.

Using the number scale below, mark the answer sheet number which corresponds to how you would respond to each following statement.

1-DISAGREE STRONGLY	2-DISAGREE	3-NEUTRAL	4-AGREE	5-STRONGLY AGREE
(1)	(2)	(3)	(4)	(5)

Concerning Implementating Two-Levels of Maintenance

12. My office has been actively involved with the planning stages of implementing two-levels of maintenance in ICBMs.

1 2 3 4 5

13. My office has been actively involved in the implementation of two-levels of maintenance in ICBMs.

1 2 3 4 5

14. The implementation of two-levels of maintenance in ICBM E-lab is complete.

1 2 3 4 5

15. Of the tasks transferred, all tasks were seldom performed tasks.

1 2 3 4 5

16. Of the tasks transferred, all tasks were associated with a low level of technician proficiency.

1 2 3 4 5

1-DISAGREE STRONGLY 2-DISAGREE 3-NEUTRAL 4-AGREE 5-STRONGLY AGREE
(1) (2) (3) (4) (5)

Concerning Mission Readiness

17. Prior to the transfer of selected maintenance tasks, the lead time for replacement parts was inadequate.

1 2 3 4 5

18. The transfer of maintenance tasks to two-levels has not adversely impacted the wing's weapon system alert rate.

1 2 3 4 5

19. As a result of the transfer of maintenance tasks, the spares availability has not adversely affected the maintenance operations at this wing.

1 2 3 4 5

20. Any parts or spares availability problems attributable to the transferred maintenance tasks have been resolved.

1 2 3 4 5

21. Of the tasks transferred, each had its own dedicated (unique to the component/task) test/support equipment.

1 2 3 4 5

Concerning resource utilization

22. For those maintenance tasks transferred and prior to transfer, there were sufficient Line/Shop Replaceable Unit (LRU, SRU) testing equipment to handle the workload.

1 2 3 4 5

23. Of the tasks transferred, the maintenance performed involved significant (more than simply minor) maintenance action(s).

1 2 3 4 5

24. As a result of the transferred tasks, the shop utilization rate has been lowered considerably.

1 2 3 4 5

1-DISAGREE STRONGLY 2-DISAGREE 3-NEUTRAL 4-AGREE 5-STRONGLY AGREE
(1) (2) (3) (4) (5)

25. As a result of the transferred tasks, the shop training requirement has been lowered considerably.

1 2 3 4 5

26. As a result of the transferred tasks, reassignment of personnel to a workcenter other than in E-lab has been or is under consideration.

1 2 3 4 5

For all respondents

27. List the top five "shop" maintenance tasks that are potentially suitable for transfer under a two-level maintenance concept. Include the associated limiting factor(s) that you feel keeps the task from being transferred.

COMPONENT/TASK LIMITING FACTOR

28. Please provide any comments you think would be beneficial to the implementation of two-levels of maintenance in ICBMs.

Please return this survey with answer sheet to: Captain Russell, c/o AFIT/LSG, W-P AFB, OH 45433 (envelope). Your confidential reply will be used only as part of combined research results. Sponsor POC: HQ SAC/LGBM, AV271-4068. Thank you for your time.

Appendix C: Research Questionnaire Data

Responses for Closed-ended Questions (Machine tabulated)
Part 1 of 3

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245 1000011                    101
345 4000000141014000333130101
350 1444401313112111121000100
324 0110111                    100
332 4332301111223211232222100
352 2111301000112221232221001
352 2000311                    111
231 2400000233322332323241111
321 1220211                    000
225 2400000244114111132020001
122 0400000030231332033200001
362 2000001                    111
222 33    00033401222122202
332 2300010013111222121100001
220 1400000340001001020113101
340 3440400111113222233111101
220 34    004313123322331110 01
225 34    00000444000404011101
333 2400000141104004304111001
363 2333300133113000132110001
233 3400000030003101143110101
334 1400000331003332113111111
343 0333300131111100031110010
123 3400000112001100131100001
353 3444400231111101131110110
344 23    00003001111131111011
334 3300000222441332333211111
241 0100010132221002333100001
341 0000011                    111
331 2002 11                    110
335 144 400333300100042111000
331 3400000341411320101000001
221 12    00440202320444400001
341 100001                     001
346 2400000031122222131121001
335 3400000333111112224222001
335 0112101034222000213020000
345 1000010                    111
343 2300000131111100031110001
350 2000011                    101
220 0   111                    101
352 20000 1                    010
330 0040011                    111
232 3400000030123332031110101
344 1000010112222322222222111
364 24 4 01                    101
234 2333310334111332043010100
353 1300000141001110030111001
323 3000010                    101
223 2000010                    110
126 0400000030101122130211011
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Note 1:
51 records; 29 items per record.
As of June 10th 1991

Note 2:
For items no. 27 and 28 the response was coded 1 for written reply, coded 2 for non-reply.

Note 3:
Item no. 29 was created to signal grade; officer was coded 1, enlisted coded 2.

Appendix C: Research Questionnaire Data

Responses to Open-ended Question No. 27 (Hand tabulated)
Part 2 of 3

1. -MTU's
2. -Magnetic Tape Unit/Troubleshoot,repair-- 180 day cal cycle still necessitates ELAB Maintenance
3. -C164A tape transport--Seldom used
   -IMPSS (security drawer)--A1 and A2 modules
   -MTU--seldom used
4. -UHF Radio Receiver Dwr--Squadron Unique Addressing
   -All DAC (Data Analysis Central Drawers)--Site Unique Strapping
   -C166B Control Monitor--EWO Levels
   -MGS Cable and Battery Installation--None
   -Minuteman Power Processor--None
5. -UHF Radio Receiver Dwr--Squadron Unique Addressing
   -All DAC (Data Analysis Central Drawers)--Site Unique Strapping
   -C166B Contro Monitor--EWO Levels
   -MGS Cable and Battery Installation--None
   -Minuteman Power Processor--None
6. -I do not agree with the two-level concept and do not think any other tasks require transfer.
7. -With the upcoming deactivation in mind, the increase in serviceable supply assets would essentially allow any supply asset to be suitable. With more spares in the system the longer turn-around times from depot should not impact alert rates.
8. -offer none
9. -Electronic Data Processing Tape Recorder Reproducer/Task: checkout, troubleshoot, repair--none
10. -not qualified to answer this.
11. -Disagree with two-level maintenance concept. If the wing needs can not be met by SMSB why have an SMSB!!
12. -Explosive set circuitry test set (TTU-463/E) (NEW)
    -Magnetic Tape Transport (C631A)
    -Keyboard Printer TO 3158-4-9-2 (NEW K/P)**
    -Signal Data Recorders: RO-277B/GSW-10; RO-595/GSW-5(NEW SDRs)**
    -Radio Frequency Amplifier (AM-7739/GRC-225)**
    -Radio Receiver Tranxmitter (RT-1536/GRC-225) (NEW MF RADIO DWRS)**
    ** All above Req. calibration; critical component, requires nuclear certification.
    -There currently exists no I-Level checkout capability for these new replacement items.

Appendix C: Research Questionnaire Data

(Part 2 of 3, Responses continued)

13. -unknown-in my opinion, transferring repairs to a depot function has resulted in long waits for parts and increased MICAP problems and lead times in dealing with depot.
14. -Alarm monitor Panel--none
    -6688/3165 Power Supply--none
    -Sequential Timer--none
    -Magnetic Core Data Storage--none
    -Programmer Group Test Set (GSM-117)--none
15. -Alarm Monitor Panel--none
    -Magnetic Core Data Storage--none
    -Calibrator Test Programmer--none
    -Launch Sequence Programmer--none
    -6689 Power Supply--none
16. -[No response] I would be giving personal preference suggestion, rather than suggestion based on research, management accounting, failure rates, cost of repair, etc.
17. -MPPs, C/O, T/S, Rep--Once deactivation starts, there should be more than enough spares to support the wings.
    -Power Supplies--same
    -Any site, OGE equipment, that an adequate number of spares can be maintained to support all wings could be added to the list.
18. -I prefer not to address the next 5 tasks to go to 2-levels of maint. Let the folks in the shops do that. The big issue is why? What costing has been done to prove savings. With the latest info on depot's charges to work, I believe units can to better, cheaper, faster. Especially as ICBM's draw down.

Appendix C: Research Questionnaire Data

Responses to Open-ended Question No. 28 (Hand tabulated) Part 3 of 3

1. Need to give the program a try. Here at [Base-X], every time a piece of equipment is really needed in the field, the two-levels of maintenance requirement is waivered. If we're going to implement this program, we need to comply with it for real.

2. We cannot tell if the program works because every time we fall below critical level on spares for one of the 2-level items the two level program is waivered and we check the component out to get us out of the bind--other problems with the program remain however. If we are going to test this program, lets test it completely and do away with the routine waivers.

3. a. Depot must repair items as they are received, not contract out "x" number of units per quarter.

b. A fast, reliable means of shipping assets must be implemented--the present system (Log-Air) doesn't meet the needs.

c. The program thus far has been a disappointment. The spare level has dropped to zero on some units and on at least two occasions, we have had to get waivers to repair assets ourselves just to stay in business. Right now, this program is not working.

4. Do not waiver any more of the two levels of maintenance tasks. By having the wings perform maintenance, a true picture is not seen by the managers at SAC.

5. [comment to the effect that tasks done at depot level can just as well be done at the wing.]

6. The 2 level maint system has not really affected this Elab. The components removed from the I-Level were low-failure items. Management needs to address the training and manning of ELab again. The lack of Basic Electronic Knowledge from the Chanute school is causing an increased workload on the Elab training system. Also, an increased emphasis on main frame troubleshooting (E-35 and 9500) should be increased.

7. I think that the tasks should be reviewed. The Air Force spent thousands of dollars bring the E-35 and now some of the drawers that we are capable of running are being sent to the depot. I feel that instead of taking tasks from the E-Lab, it should be the other way around, giving tasks

(Part 3 of 3, Responses continued)

that are done at depot to the wings, such as repairing circuit boards.

8. I could give a better comment if I knew which way that we are headed. [To] Completely do away with ELAB or just [to keep] Depot busy [?]. Personnally I think that what has been chosen as task so far does not give a clear tasking of depot. It looks as if we are [trying to] justifying the jobs at depot. . . .

9. The goals of the AIM have not been clearly stated. Is the goal to increase the workload at depot facilities or to decrease the workload at the ELab[?]. Or, is the goal to do away with ELab completely[?]. A clear statement of the goals of the [ALM] will allow us to plan and implement the transferring of more items to depot-level maintenance.

10. I think two-level maintenance is headed in the wrong direction. The leading concern is turn around time. If the units were allowed to do more repair turn around time would be reduced. The E-35 makes identification of bad components easier. I think ELab should be allowed to do component repair. The quality of parts from depot is marginal at best.

11. In my opinion, transfer of support/test equipment to depot is not a good idea. A limited number of assets combined with a long turn-around time from depot could severely impact alert rates.

12. The two levels of maintenance is an extreme waste of time and money. We can still work all [drawers] under the 2 levels of maintenance and we still do with SAC's permission, normally in less than 2 hours. Let us have full power of [drawer] repair and we can save the Air Force money.

13. Disagree with the current approach for two-levels of maintenance. This would be a good program to implement on a new weapon system coming on line, but not on an aged system. Believe we took the wrong approach to solve our problem without adequate logair support and LRU/SRU quantities, this program is not viable. The answer is to civilianize the intermediate shops and keep three levels of maintenance. This would almost eliminate the training problem and allow the attrition rate to become almost NIL. Would also allow some depot task to be transferred to intermediate [-level maintenance].

(Part 3 of 3, Responses continued)

14. ICBMs, of all USAF weapon systems, are uniquely suited to centralized maintenance, and intermediate level activities are appropriate and cost effective. Deployable systems lend themselves to 2-level much more readily. Transferring all tasks would require an increase in spares to keep the pipeline running, perhaps delay maintenance-effecting alert rates, and take critical control of alert generating maintenance out of the hands of the operational user.

15. The two level maintenance has caused a considerable amount of time delay in receiving servicable equipment back from depot, i.e., 5 months.

16. Frankly, I don't like the program (that's why #27 was left blank.)

17. Right now PREL shop is doing a large amount of two-level [maintenance].

18. I feel the 2-levels of maintenance will limit our ability to keep missiles on alert. There are few enough spares in the systems at present. I do not see how we can maintain our current capabilities while critical spares are spending even more time in the pipeline.

19. Obviously there are inadequate spares in the system to support two-levels, particularly on the Electrical Power Test Set [EPTS]. This task has been waivered several times when wing levels have become critical. The two-levels concept will not, cannot work when we waiver the program every time we get in a pinch. This program has not benefitted the ELAB in the least as most work requirements are still the same.

20. Two-levels of maintenance was never meant for ICBMs. We have too few spares in the system and depot is not responsive enough to fix them in a timely manner. The unit should have retained all of its previous repair capabilities. Units are [experiencing] excessively long MICAP fill times.

21. [Give] us the things we need to repair whatever breaks.

22. Sincere willingness to accept lower alert rate by commanders. All new or replacement equipment should be designed under the two-level maintenance concept.

Appendix C: Research Questionnaire Data

(Part 3 of 3, Responses continued)

23. Sounds good on paper but [the] implementation [still has] problems.

24. Due to the run time of critical components on the E-35 (after implementation). Have depot work all programmer group drawers. They have a low failure rate and the cost of repair and man hours are high. The drawers take a lot of time to troubleshoot and repair.

25. While it may be possible to delete some maintenance tasks from ELab, there remain numerous tasks which could never be effectively sent to depot. For this reason the ELab must remain at the bases. Those tasks which have already been deleted take little away from our workload and don't return any cost savings to the Air Force. Because it is far less expensive for us to repair the units rather than shipping them off for repair.

26. The actions to establish a two-level of maintenance program in ICBMs [were] done at the Shop Chief level here at [Base-X]/MBQ). Ogden provided [their] suggested list on past failure but wing [BASE-X] never [revalidated] that list with this or historical data for concurrence.

27. Spares, spares, spares! You can have everything and shutdown ELab, but when a [site] is sitting off-alert because a drawer or a piece of test equipment is not available, heads will roll!! Maintenance communities are way too aggressive for this type of program. They must have critical assets available.

28. Two-level maintenance does not seem to work, we pull a two-level component and ship it off for repair, yet we don't receive a replacement component for months. (IE. 6521 Power supplies) In years past ELab was able to repair these items just fine, lets let them continue.

29. Spare levels must increase, this should have been done prior to implementation. Without spares and a better response from Depot the sytem does not work.

30. Missile sites must be maintained with power, security, monitoring capability at all times [because of the nature of the weapons] stored there (whether the site is launch ready or not). The first thing we need is an adequate level of spares in place, at the unit. Two-levels hasn't provided us improved spare support--in fact, jus the opposite. Luckily we only gave away seldom repaired items.

Appendix C: Research Questionnaire Data

(Part 3 of 3, Responses continued)

31. I do not believe two-level maintenance will work under the current conditions. There are not enough spares in the system to satisfy customer needs when you take into account the lag time between depot and base. In addition, you can not instill a "sense of urgency" in a depot the way you can your own base agencies. Currently depot can't handle the volume they have. How are they suppose to handle more?

32. I don't like it! The MM --> business needs quicker response time not slower. Deterence has no price tag!

33. Keep units capability to highest levels possible. Transfer of assets means larger repair cycle times.

Appendix D: Research Demographic Data

TABLE 16

Response Variable: Enlisted Respondent AFSC (17)

AFSC:	41150	41170	41199	41100
Observations:	4	16	10	4
Percentage: (100.0% responding)	8.0	32.0	20.0	8.0

TABLE 17

Response Variable: Officer Respondent AFSC (17)

AFSC:	3124	3116	A3116	3196	OTHER
Observations:	3	5	1	3	4
Percentage: (100.0% responding)	6.0	10.0	2.0	6.0	8.0

TABLE 18

Response Variable: Time Respondents have held Their Present Position (17)

Month(s):	0-6	7-12	13-24	25 or more
Observations:	9	11	17	12
Percentage: (100.0% responding)	17.6	21.6	33.3	27.4

Appendix D: Research Demographic Data

(Continued)

TABLE 19

Response Variable: Respondent's Experience with the Mechanical Shop (Indicated by the length of time supervised or worked in) (17)

Month(s):	0	1-6	7-12	13-24	25 or more
Observations:	31	3	1	4	5
Percentage: (86.3% responding)	70.5	6.8	2.3	9.1	11.4

TABLE 20

Response Variable: Respondent's Experience with the Pneudraulics Shop (Indicated by the length of time supervised or worked in) (17)

Months:	0	1-6	7-12	13-24	25 or more
Observations:	34	1	3	3	3
Percentage: (86.3% responding)	77.3	2.3	6.8	6.8	6.8

Appendix D: Research Demographic Data

(Continued)

TABLE 21

Response Variable: Respondent's Experience with the PREL Shop (PREL- Power, Refrigeration and Electrical Shop) (Indicated by the length of time supervised or worked in) (17)

Months:	0	1-6	7-12	13-24	25 or more
Observations:	30	3	1	6	4
Percentage: (86.3% responding)	68.2	6.8	2.3	13.6	9.1

Appendix E: Survey Distribution

Wings:

341st Strategic Missile Wing
44th Strategic Missile Wing
91st Strategic Missile Wing
351st Strategic Missile Wing
90th Strategic Missile Wing
321st Strategic Missile Wing
394th ICBM Test Maintenance Squadron

Offices:

MB
MBM
MBMS
MBMJ/Shops Scheduler
MBQ
MBQ/E-LAB EVALUATOR
FMMS/CC
FMMS/MBA
FMMS/MBAF
FMMS/MBAS
FMMS/MBASE/NCOIC
FMMS/MBASE/Shop Scheduler
FMMS/MBASE/Shop Trainer
MBAFE/NCOIC *
MBAFE/Shop Scheduler *
MBAFE/Shop Trainer *

* 394th ICBM TMS only

Appendix F: Reliability Test

Initial Reliability Test
(With original grouping, Part 1 of 2)

```
120 Jun 91    SPSS-X Release 3.0 for VAX/UNIX     Page   1
14:49:12     AFIT                 AX/785          UNIX BSD 4.3

For UNIX BSD 4.3          AFIT           License Number 19377
This software is functional through September 30, 1991.

    1  0  title          'Survey Data on SPSS'
    2  0
    3  0  file handle    newdat/name='opsscan4.dat'
    4  0
    5  0  data list      file=newdat  fixed  records=1/
    6  0                 yrsserv grade wing afsc postime
                         elabexp
    7  0                 mechexp pneuexp prelexp presept
                         postsept
    8  0                 planned implem implcomp seldperf prof
    9  0                 leadtime alrtimpt sprsimpt nsprsprb
   10  0                 dedequip enufequp signmnx shoputil
   11  0                 shoptng persmov topfive commt offenl
   12  0                 (29f1.0)

 THE COMMAND ABOVE READS   1 RECORDS FROM opsscan4.dat
```

VARIABLE	REC	START	END	FORMAT	WIDTH	DEC
YRSSERV	1	1	1	F	1	0
GRADE	1	2	2	F	1	0
WING	1	3	3	F	1	0
AFSC	1	4	4	F	1	0
POSTIME	1	5	5	F	1	0
ELABEXP	1	6	6	F	1	0
MECHEXP	1	7	7	F	1	0
PNEUEXP	1	8	8	F	1	0
PRELEXP	1	9	9	F	1	0
PRESEPT	1	10	10	F	1	0
POSTSEPT	1	11	11	F	1	0
PLANNED	1	12	12	F	1	0
IMPLEM	1	13	13	F	1	0
IMPLCOMP	1	14	14	F	1	0
SELDPERF	1	15	15	F	1	0
PROF	1	16	16	F	1	0
LEADTIME	1	17	17	F	1	0
ALRTIMPT	1	18	18	F	1	0
SPRSIMPT	1	19	19	F	1	0
NSPRSPRB	1	20	20	F	1	0
DEDEQUIP	1	21	21	F	1	0

Appendix F: Reliability Test

(Part 1 of 2, Continued)

ENUFEQUP	1	22	22	F	1	0
SIGNMNX	1	23	23	F	1	0
SHOPUTIL	1	24	24	F	1	0
SHOPTNG	1	25	25	F	1	0
PERSMOV	1	26	26	F	1	0
TOPFIVE	1	27	27	F	1	0
COMMT	1	28	28	F	1	0
OFFENL	1	29	29	F	1	0

END OF DATALIST TABLE

```
14  0  set      blanks=99
15  0
16  0  recode   yrsserv to offenl (0=1) (1=2) (2=3) (3=4)
17  0                   (4=5) (5=6) (6=7) (7=8) (8=99)
18  0
19  0  missing values yrsserv to offenl (99)
20  0
21  0  compute Implmnt=planned+implem+implcomp+
                seldperf+prof
22  0
23  0  compute ready=leadtime+alrtimpt+sprsimpt+
                nsprsprb+dedequip
24  0
25  0  compute utilize=enufequp+signmnx+shoputil+
                shoptng+persmov
26  0
27  0  reliability      Variables=planned to prof/
28  0                   Scale(implmnt)=planned to prof/
29  0                   Variables=leadtime to dedequip/
30  0                   Scale(ready)=leadtime to dedequip/
31  0                   Variables=enufequp to persmov/
32  0                   Scale(utilize)=enufequp to persmov/
33  0                   /summary=total
34  0
35  0  statistics       1 9
36  0
37  0  finish
```

Appendix F: Reliability Test

(Part 1 of 2, Continued)

RELIABILITY ANALYSIS - SCALE (I M P L M N T)

1. PLANNED
2. IMPLEM
3. IMPLCOMP
4. SELDPERF
5. PROF

		MEAN	STD DEV	CASES
1.	PLANNED	2.3714	1.2853	35.0
2.	IMPLEM	3.5714	1.2435	35.0
3.	IMPLCOMP	2.6000	1.3106	35.0
4.	SELDPERF	2.4857	1.2455	35.0
5.	PROF	2.1143	1.0784	35.0

ITEM-TOTAL STATISTICS

	SCALE MEAN IF ITEM DELETED	SCALE VARIANCE IF ITEM DELETED	CORRECTED ITEM-TOTAL CORRELATION	ALPHA IF ITEM DELETED
PLANNED	10.7714	6.5345	.2235	.1135
IMPLEM	9.5714	8.0756	.0048	.3288
IMPLCOMP	10.5429	7.3731	.0793	.2641
SELDPERF	10.6571	6.0555	.3342	-.0052
PROF	11.0286	8.5580	-.0104	.3257

RELIABILITY COEFFICIENTS

N OF CASES = 35.0 N OF ITEMS = 5

*** ALPHA = 0.2622 (Initial)

Appendix F: Reliability Test

(Part 1 of 2, Continued)

RELIABILITY ANALYSIS - SCALE (R E A D Y)

1. LEADTIME
2. ALRTIMPT
3. SPRSIMPT
4. NSPRSPRB
5. DEDEQUIP

		MEAN	STD DEV	CASES
1.	LEADTIME	2.8857	1.1054	35.0
2.	ALRTIMPT	2.5429	1.1205	35.0
3.	SPRSIMPT	2.2857	1.1775	35.0
4.	NSPRSPRB	2.2000	.9941	35.0
5.	DEDEQUIP	2.4286	1.1704	35.0

ITEM-TOTAL STATISTICS

	SCALE MEAN IF ITEM DELETED	SCALE VARIANCE IF ITEM DELETED	CORRECTED ITEM-TOTAL CORRELATION	ALPHA IF ITEM DELETED
LEADTIME	9.4571	9.4319	.1111	.6265
ALRTIMPT	9.8000	7.5765	.4177	.4593
SPRSIMPT	10.0571	6.7025	.5444	.3714
NSPRSPRB	10.1429	8.0084	.4286	.4620
DEDEQUIP	9.9143	8.7277	.1896	.5921

RELIABILITY COEFFICIENTS

N OF CASES = 35.0 N OF ITEMS = 5

*** ALPHA = 0.5683 (Initial)

Appendix F: Reliability Test

(Part 1 of 2, Continued)

RELIABILITY ANALYSIS - SCALE (U T I L I Z E)

1. ENUFEQUP
2. SIGNMNX
3. SHOPUTIL
4. SHOPTNG
5. PERSMOV

		MEAN	STD DEV	CASES
1.	ENUFEQUP	3.5429	1.0667	35.0
2.	SIGNMNX	3.0857	1.1973	35.0
3.	SHOPUTIL	2.1714	.8220	35.0
4.	SHOPTNG	2.1143	.9000	35.0
5.	PERSMOV	1.6857	.7960	35.0

ITEM-TOTAL STATISTICS

	SCALE MEAN IF ITEM DELETED	SCALE VARIANCE IF ITEM DELETED	CORRECTED ITEM-TOTAL CORRELATION	ALPHA IF ITEM DELETED
ENUFEQUP	9.0571	5.1143	-.0376	.4071
SIGNMNX	9.5143	4.3160	.0645	.3271
SHOPUTIL	10.4286	3.9580	.4394	-.0192
SHOPTNG	10.4857	4.4336	.2182	.1663
PERSMOV	10.9143	5.0807	.0993	.2686

RELIABILITY COEFFICIENTS

N OF CASES = 35.0 N OF ITEMS = 5

*** ALPHA = 0.2841 (Initial)

Appendix F: Reliability Test

Follow-on Reliability Test (With new grouping, Part 2 of 2)

```
113 Aug 91   SPSS-X Release 3.0 for VAX/UNIX      Page   1
20:05:34     AFIT                     VAX/785      UNIX BSD 4.3

For UNIX BSD 4.3          AFIT              License Number 19377
 This software is functional through September 30, 1991.

    1  0  title          'Alpha Run'
    2  0
    3  0  file handle    newdat/name='opsscan4.dat'
    4  0
    5  0  data list      file=newdat  fixed  records=1/
    6  0                 yrsserv grade wing afsc postime
                         elabexp
    7  0                 mechexp pneuexp prelexp presept
                         postsept
    8  0                 planned implem implcomp seldperf
                         prof
    9  0                 leadtime alrtimpt sprsimpt nsprsprb
   10  0                 dedequip enufequp signmnx shoputil
   11  0                 shoptng persmov topfive commt
                         offenl
   12  0                 (29f1.0)

 THE COMMAND ABOVE READS   1 RECORDS FROM opsscan4.dat
```

VARIABLE	REC	START	END	FORMAT	WIDTH	DEC
YRSSERV	1	1	1	F	1	0
GRADE	1	2	2	F	1	0
WING	1	3	3	F	1	0
AFSC	1	4	4	F	1	0
POSTIME	1	5	5	F	1	0
ELABEXP	1	6	6	F	1	0
MECHEXP	1	7	7	F	1	0
PNEUEXP	1	8	8	F	1	0
PRELEXP	1	9	9	F	1	0
PRESEPT	1	10	10	F	1	0
POSTSEPT	1	11	11	F	1	0
PLANNED	1	12	12	F	1	0
IMPLEM	1	13	13	F	1	0
IMPLCOMP	1	14	14	F	1	0
SELDPERF	1	15	15	F	1	0
PROF	1	16	16	F	1	0
LEADTIME	1	17	17	F	1	0
ALRTIMPT	1	18	18	F	1	0
SPRSIMPT	1	19	19	F	1	0
NSPRSPRB	1	20	20	F	1	0

(Part 2 of 2, Continued)

DEDEQUIP	1	21	21	F	1	0
ENUFEQUP	1	22	22	F	1	0
SIGNMNX	1	23	23	F	1	0
SHOPUTIL	1	24	24	F	1	0
SHOPTNG	1	25	25	F	1	0
PERSMOV	1	26	26	F	1	0
TOPFIVE	1	27	27	F	1	0
COMMT	1	28	28	F	1	0
OFFENL	1	29	29	F	1	0

END OF DATALIST TABLE

```
set        blanks=99

recode     yrsserv to offenl (0=1) (1=2) (2=3)(3=4)
           (4=5) (5=6) (6=7) (7=8) (8=99)

recode     leadtime (1=5) (2=4) (4=2) (5=1)

recode     alrtimpt (1=5) (2=4) (4=2) (5=1)

recode     sprsimpt (1=5) (2=4) (4=2) (5=1)

missing values yrsserv to offenl (99)

compute    prog=planned+implem

compute    elem=seldperf+prof+dedequip+signmnx

compute    impct=alrtimpt+sprsimpt

reliability Variables=planned implem/
              Scale(prog)=planned implem/
           Variables=seldperf prof dedequip signmnx/
         Scale(elem)=seldperf prof dedequip signmnx/
           Variables=alrtimpt sprsimpt/
        Scale(impct)=alrtimpt sprsimpt/
             /summary=total

statistics     1 9

finish
```

Appendix F: Reliability Test

(Part 2 of 2, Continued)

RELIABILITY ANALYSIS - SCALE (P R O G)

1. PLANNED
2. IMPLEM

		MEAN	STD DEV	CASES
1.	PLANNED	2.3714	1.2853	35.0
2.	IMPLEM	3.5714	1.2435	35.0

ITEM-TOTAL STATISTICS

	SCALE MEAN IF ITEM DELETED	SCALE VARIANCE IF ITEM DELETED	CORRECTED ITEM-TOTAL CORRELATION	ALPHA IF ITEM DELETED
PLANNED	3.5714	1.5462	.3602	.
IMPLEM	2.3714	1.6521	.3602	.

RELIABILITY COEFFICIENTS

N OF CASES = 35.0 N OF ITEMS = 2

*** ALPHA = 0.5294 (Final)

Appendix F: Reliability Test

(Part 2 of 2, Continued)

RELIABILITY ANALYSIS - SCALE (E L E M)

1. SELDPERF
2. PROF
3. DEDEQUIP
4. SIGNMNX

		MEAN	STD DEV	CASES
1.	SELDPERF	2.4857	1.2455	35.0
2.	PROF	2.1143	1.0784	35.0
3.	DEDEQUIP	2.4286	1.1704	35.0
4.	SIGNMNX	3.0857	1.1973	35.0

ITEM-TOTAL STATISTICS

	SCALE MEAN IF ITEM DELETED	SCALE VARIANCE IF ITEM DELETED	CORRECTED ITEM-TOTAL CORRELATION	ALPHA IF ITEM DELETED
SELDPERF	7.6286	7.5933	.5083	.7165
PROF	8.0000	8.3529	.5001	.7180
DEDEQUIP	7.6857	7.3395	.6189	.6523
SIGNMNX	7.0286	7.4992	.5643	.6831

RELIABILITY COEFFICIENTS

N OF CASES = 35.0 N OF ITEMS = 4

*** ALPHA = 0.7510 (Final)

Appendix F: Reliability Test

(Part 2 of 2, Continued)

RELIABILITY ANALYSIS - SCALE (I M P C T)

1. ALRTIMPT
2. SPRSIMPT

		MEAN	STD DEV	CASES
1.	ALRTIMPT	3.4571	1.1205	35.0
2.	SPRSIMPT	3.7143	1.1775	35.0

ITEM-TOTAL STATISTICS

	SCALE MEAN IF ITEM DELETED	SCALE VARIANCE IF ITEM DELETED	CORRECTED ITEM-TOTAL CORRELATION	ALPHA IF ITEM DELETED
ALRTIMPT	3.7143	1.3866	.9044	.
SPRSIMPT	3.4571	1.2555	.9044	.

RELIABILITY COEFFICIENTS

N OF CASES = 35.0 N OF ITEMS = 2

*** ALPHA = 0.9492 (Final)

Appendix G: Student's T-Tests

T-Tests for Twelve Demographic Variables: Enlisted (Part 1 of 8)

```
102 Jul 91   SPSS-X Release 3.0 for VAX/UNIX                 Page   1
18:39:52     AFIT                           VAX/785          UNIX BSD 4.3

   1  0  title          'T-Test1'
   2  0
   3  0  file handle    newdat/name='opsscan5.dat'
   4  0
   5  0  data list      file=newdat  fixed  records=1/
   6  0                 yrsserv enl wing off postime elabexp
   7  0                 mechexp pneuexp prelexp presept postsept
   8  0                 planned implem implcomp seldperf prof
   9  0                 leadtime alrtimpt sprsimpt nsprsprb
  10  0                 dedequip enufequp signmnx shoputil
  11  0                 shoptng persmov topfive commt offenl
  12  0                 (29f1.0)

 THE COMMAND ABOVE READS   1 RECORDS FROM opsscan5.dat
```

VARIABLE	REC	START	END	FORMAT	WIDTH	DEC
YRSSERV	1	1	1	F	1	0
ENL	1	2	2	F	1	0
WING	1	3	3	F	1	0
OFF	1	4	4	F	1	0
POSTIME	1	5	5	F	1	0
ELABEXP	1	6	6	F	1	0
MECHEXP	1	7	7	F	1	0
PNEUEXP	1	8	8	F	1	0
PRELEXP	1	9	9	F	1	0
PRESEPT	1	10	10	F	1	0
POSTSEPT	1	11	11	F	1	0
PLANNED	1	12	12	F	1	0
IMPLEM	1	13	13	F	1	0
IMPLCOMP	1	14	14	F	1	0
SELDPERF	1	15	15	F	1	0
PROF	1	16	16	F	1	0
LEADTIME	1	17	17	F	1	0
ALRTIMPT	1	18	18	F	1	0
SPRSIMPT	1	19	19	F	1	0
NSPRSPRB	1	20	20	F	1	0
DEDEQUIP	1	21	21	F	1	0
ENUFEQUP	1	22	22	F	1	0
SIGNMNX	1	23	23	F	1	0
SHOPUTIL	1	24	24	F	1	0
SHOPTNG	1	25	25	F	1	0
PERSMOV	1	26	26	F	1	0

(Part 1 of 8, Continued)

TOPFIVE	1	27	27	F	1	0
COMMT	1	28	28	F	1	0
OFFENL	1	29	29	F	1	0

END OF DATALIST TABLE

```
14  0  set            blanks=99
15  0
16  0  recode         yrsserv to offenl (0=1) (1=2) (2=3) (3=4)
17  0                 (4=5) (5=6) (6=7) (7=8) (8=99)
18  0
19  0  recode         leadtime (1=5) (2=4) (4=2) (5=1)
20  0
21  0  recode         alrtimpt (1=5) (2=4) (4=2) (5=1)
22  0
23  0  recode         sprsimpt (1=5) (2=4) (4=2) (5=1)
24  0
25  0  missing values yrsserv to offenl (99)
26  0
27  0  compute        prog=planned+implem
28  0
29  0  compute        elem=seldperf+prof+dedequip+signmnx
30  0
31  0  compute        impct=alrtimpt+sprsimpt
32  0
33  0  t-test         groups=enl(5)/variables=prog elem impct
34  0
35  0  options        2 4
36  0
```

(Part 1 of 8, Continued)

- - - - - - - - - - - - - - T - T E S T - - - - - - - - - - - - - - - - -

GROUP 1 - ENL GE 5
GROUP 2 - ENL LT 5

VARIABLE		NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
PROG					
	GROUP 1	10	4.9000	1.853	0.586
	GROUP 2	18	6.3889	2.279	0.537

		*	POOLED VARIANCE ESTIMATE			*	SEPARATE VARIANCE ESTIMATE		
F VALUE	2-TAIL PROB.	*	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.51	0.536	*	-1.76	26	0.090	*	-1.87	22.19	0.074

VARIABLE		NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
ELEM					
	GROUP 1	10	9.3000	2.983	0.943
	GROUP 2	18	10.8333	4.204	0.991

(Part 1 of 8, Continued)

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.99	0.296	*	-1.02	26	0.319	*	-1.12	24.21	0.273

- - - - - - - - - - - - - - - - - - T - T E S T - - - - - - - - - - - - - - -

GROUP 1 - ENL GE 5
GROUP 2 - ENL LT 5

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
IMPCT				
GROUP 1	10	7.8000	1.932	0.611
GROUP 2	18	6.5000	2.383	0.562

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.52	0.530	*	1.47	26	0.153	*	1.57	22.23	0.131

Appendix G: Student's T-Tests

T-Tests for Twelve Demographic Variables: Years of Service (Part 2 of 8)

```
.
.
.
33  0  t-test        groups=yrsserv(3)/variables=prog elem impct
34  0
35  0  options       2 4
36  0
```

- - - - - - - - - - - - - - - - - T - T E S T - - - - - - - - - - - - - -

GROUP 1 - YRSSERV GE 3
GROUP 2 - YRSSERV LT 3

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
PROG				
GROUP 1	32	6.0625	2.139	0.378
GROUP 2	3	4.6667	0.577	0.333

		* POOLED VARIANCE ESTIMATE			* SEPARATE VARIANCE ESTIMATE		
F VALUE	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
13.73	0.140	* 1.11	33	0.274	* 2.77	9.45	0.021

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
ELEM				
GROUP 1	32	10.3125	3.551	0.628
GROUP 2	3	8.0000	3.464	2.000

(Part 2 of 8, Continued)

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE: T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE: T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.05	1.206	*	1.08	33	0.288	*	1.10	2.41	0.368

\- T - T E S T - - - - - - - - - - - - - - - -

GROUP 1 - YRSSERV GE 3
GROUP 2 - YRSSERV LT 3

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
IMPCT				
GROUP 1	32	7.2188	2.254	0.398
GROUP 2	3	6.6667	2.517	1.453

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE: T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE: T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.25	0.603	*	0.40	33	0.690	*	0.37	2.31	0.745

Appendix G: Student's T-Tests

T-Tests for Twelve Demographic Variables: ELab Experience (Part 3 of 8)

```
.
.
.
33  0  t-test        groups=elabexp(4)/variables=prog elem impct
34  0
35  0  options       2 4
36  0
```

- - - - - - - - - - - - - - - - - - T - T E S T- - - - - - - - - - - - - -

GROUP 1 - ELABEXP GE 4
GROUP 2 - ELABEXP LT 4

VARIABLE		NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
PROG					
	GROUP 1	29	6.0000	1.982	0.368
	GROUP 2	6	5.6667	2.733	1.116

		* POOLED VARIANCE ESTIMATE			* SEPARATE VARIANCE ESTIMATE		
F VALUE	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.90	0.252	* 0.35	33	0.727	* 0.28	6.13	0.786

VARIABLE		NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
ELEM					
	GROUP 1	29	9.6552	3.687	0.685
	GROUP 2	6	12.3333	1.633	0.667

(Part 3 of 8, Continued)

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
5.10	0.077	*	-1.73	33	0.093	*	-2.80	17.61	0.012

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GROUP 1 - ELABEXP GE 4
GROUP 2 - ELABEXP LT 4

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
IMPCT				
GROUP 1	29	7.0690	2.203	0.409
GROUP 2	6	7.6667	2.582	1.054

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.37	0.528	*	-0.59	33	0.560	*	-0.53	6.59	0.614

T-Tests for Twelve Demographic Variables: Mech Experience
(Part 4 of 8)

```
  .
  .
  .
  33  0  t-test         groups=mechexp(4)/variables=prog elem impct
  34  0
  35  0  options        2 4
  36  0
```

- - - - - - - - - - - - - - - - - T - T E S T- - - - - - - - - - - - - -

GROUP 1 - MECHEXP GE 4
GROUP 2 - MECHEXP LT 4

VARIABLE		NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
PROG					
	GROUP 1	8	6.1250	1.553	0.549
	GROUP 2	27	5.8889	2.242	0.431

		* POOLED VARIANCE ESTIMATE			* SEPARATE VARIANCE ESTIMATE		
F VALUE	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
2.08	0.319	* 0.28	33	0.783	* 0.34	16.61	0.739

VARIABLE		NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
ELEM					
	GROUP 1	8	9.1250	1.642	0.581
	GROUP 2	27	10.4074	3.925	0.755

(Part 4 of 8, Continued)

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE: T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE: T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
5.71	0.024	*	-0.89	33	0.378	*	-1.35	28.65	0.189

\- - - - - - - - - - - - - - - - - - T - T E S T - - - - - - - - - - - - - -

GROUP 1 - MECHEXP GE 4
GROUP 2 - MECHEXP LT 4

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
IMPCT				
GROUP 1	8	7.7500	1.982	0.701
GROUP 2	27	7.0000	2.320	0.447

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE: T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE: T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.37	0.703	*	0.83	33	0.414	*	0.90	13.25	0.383

Appendix G: Student's T-Tests

T-Tests for Twelve Demographic Variables: Pneu Experience
(Part 5 of 8)

```
.
.
.
33  0  t-test       groups=pneuexp(4)/variables=prog elem impct
34  0
35  0  options      2 4
36  0
```

- - - - - - - - - - - - - - - - - - T - T E S T- - - - - - - - - - - - - -

GROUP 1 - PNEUEXP GE 4
GROUP 2 - PNEUEXP LT 4

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
PROG				
GROUP 1	5	6.6000	0.894	0.400
GROUP 2	30	5.8333	2.214	0.404

		*	POOLED VARIANCE ESTIMATE			*	SEPARATE VARIANCE ESTIMATE		
F VALUE	2-TAIL PROB.	*	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
6.13	0.089	*	0.76	33	0.455	*	1.35	14.29	0.199

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
ELEM				
GROUP 1	5	8.2000	0.837	0.374
GROUP 2	30	10.4333	3.739	0.683

(Part 5 of 8, Continued)

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
19.97	0.010	*	-1.31	33	0.198	*	-2.87	29.64	0.008

\- - - - - - - - - - - - - - - - - - T - T E S T - - - - - - - - - - - - - -

GROUP 1 - PNEUEXP GE 4
GROUP 2 - PNEUEXP LT 4

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
IMPCT				
GROUP 1	5	8.0000	2.345	1.049
GROUP 2	30	7.0333	2.236	0.408

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.10	0.750	*	0.89	33	0.380	*	0.86	5.29	0.428

T-Tests for Twelve Demographic Variables: PREL Experience
(Part 6 of 8)

```
 .
 .
 .
 33  0  t-test        groups=prelexp(4)/variables=prog elem impct
 34  0
 35  0  options       2 4
 36  0
```

- - - - - - - - - - - - - - - - - - T - T E S T- - - - - - - - - - - - - -

GROUP 1 - PRELEXP GE 4
GROUP 2 - PRELEXP LT 4

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
PROG				
GROUP 1	9	5.6667	2.000	0.667
GROUP 2	26	6.0385	2.144	0.421

		POOLED VARIANCE ESTIMATE			SEPARATE VARIANCE ESTIMATE		
F VALUE	2-TAIL PROB.	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.15	0.892	-0.46	33	0.652	-0.47	14.88	0.644

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
ELEM				
GROUP 1	9	9.2222	1.563	0.521
GROUP 2	26	10.4231	4.002	0.785

(Part 6 of 8, Continued)

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
6.55	0.010	*	-0.87	33	0.390	*	-1.27	32.29	0.212

\- - - - - - - - - - - - - - - - - - - T - T E S T - - - - - - - - - - - - - -

GROUP 1 - PRELEXP GE 4
GROUP 2 - PRELEXP LT 4

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
IMPCT				
GROUP 1	9	7.5556	1.944	0.648
GROUP 2	26	7.0385	2.358	0.462

F VALUE	2-TAIL PROB.	*	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	*	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.47	0.590	*	0.59	33	0.559	*	0.65	16.83	0.525

Appendix G: Student's T-Tests

T-Tests for Twelve Demographic Variables: Pre-September Experience (Part 7 of 8)

```
.
.
.
33  0  t-test        groups=presept/variables=prog elem impct
34  0
35  0  options       2 4
36  0
```

- - - - - - - - - - - - - - - - - - - T - T E S T- - - - - - - - - - - - - -

GROUP 1 - PRESEPT EQ 1
GROUP 2 - PRESEPT EQ 2

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
PROG				
GROUP 1	31	6.0323	2.089	0.375
GROUP 2	4	5.2500	2.217	1.109

		* POOLED VARIANCE ESTIMATE			* SEPARATE VARIANCE ESTIMATE		
F VALUE	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.13	0.708	* 0.70	33	0.488	* 0.67	3.72	0.543

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
ELEM				
GROUP 1	31	10.0323	3.674	0.660
GROUP 2	4	10.7500	2.754	1.377

(Part 7 of 8, Continued)

F VALUE	2-TAIL PROB.	* POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	* SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.78	0.711	* -0.38	33	0.710	* -0.47	4.51	0.660

- - - - - - - - - - - - - - - - - - T - T E S T - - - - - - - - - - - - - - -

GROUP 1 - PRESEPT EQ 1
GROUP 2 - PRESEPT EQ 2

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
IMPCT				
GROUP 1	31	7.2903	2.209	0.397
GROUP 2	4	6.2500	2.630	1.315

F VALUE	2-TAIL PROB.	* POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	* SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.42	0.514	* 0.87	33	0.391	* 0.76	3.57	0.496

T-Tests for Twelve Demographic Variables: Post-September Experience (Part 8 of 8)

```
 .
 .
 .
33 0 t-test        groups=postsept/variables=prog elem impct
34 0
35 0 options       2 4
36 0
```

- - - - - - - - - - - - - - - - - - - T - T E S T - - - - - - - - - - - - - - -

GROUP 1 - POSTSEPT EQ 1
GROUP 2 - POSTSEPT EQ 2

VARIABLE		NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
PROG					
	GROUP 1	31	6.1613	2.051	0.368
	GROUP 2	4	4.2500	1.708	0.854

		* POOLED VARIANCE ESTIMATE			* SEPARATE VARIANCE ESTIMATE		
F VALUE	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	* T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.44	0.873	* 1.78	33	0.084	* 2.06	4.21	0.106

VARIABLE		NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
ELEM					
	GROUP 1	31	10.0323	3.710	0.666
	GROUP 2	4	10.7500	2.217	1.109

(Part 8 of 8, Continued)

F VALUE	2-TAIL PROB.	* POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	* SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
2.80	0.431	* -0.38	33	0.710	* -0.55	5.49	0.601

- T - T E S T- - - - - - - - - - - - - - - -

GROUP 1 - POSTSEPT EQ 1
GROUP 2 - POSTSEPT EQ 2

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
IMPCT				
GROUP 1	31	7.0968	2.315	0.416
GROUP 2	4	7.7500	1.708	0.854

F VALUE	2-TAIL PROB.	* POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	* SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
1.84	0.689	* -0.54	33	0.591	* -0.69	4.56	0.525

Appendix H: New Variable Grouping Frequency Count

Variable: PROGRAM (PROG)

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	2.00	3	5.9	8.6	8.6
	3.00	1	2.0	2.9	11.4
	4.00	4	7.8	11.4	22.9
	5.00	7	13.7	20.0	42.9
	6.00	6	11.8	17.1	60.0
	7.00	5	9.8	14.3	74.3
	8.00	5	9.8	14.3	88.6
	9.00	3	5.9	8.6	97.1
	10.00	1	2.0	2.9	100.0
	.	16	31.4	MISSING	
	TOTAL	51	100.0	100.0	

VALID CASES 35 MISSING CASES 16

Variable: ELEMENT (ELEM)

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	4.00	2	3.9	5.7	5.7
	6.00	3	5.9	8.6	14.3
	7.00	2	3.9	5.7	20.0
	8.00	6	11.8	17.1	37.1
	9.00	5	9.8	14.3	51.4
	10.00	1	2.0	2.9	54.3
	11.00	4	7.8	11.4	65.7
	12.00	5	9.8	14.3	80.0
	13.00	2	3.9	5.7	85.7
	14.00	2	3.9	5.7	91.4
	15.00	1	2.0	2.9	94.3
	18.00	1	2 0	2.9	97.1
	20.00	1	2.0	2.9	100.0
	.	16	31.4	MISSING	
	TOTAL	51	100.0	100.0	

VALID CASES 35 MISSING CASES 16

Appendix H: New Variable Grouping Frequency Count

(Continued)

VARIABLE: IMPACT (IMPCT)

VALUE LABEL	VALUE	FREQUENCY	PERCENT	VALID PERCENT	CUM PERCENT
	4.00	7	13.7	20.0	20.0
	5.00	3	5.9	8.6	28.6
	6.00	5	9.8	14.3	42.9
	7.00	2	3.9	5.7	48.6
	8.00	5	9.8	14.3	62.9
	9.00	6	11.8	17.1	80.0
	10.00	7	13.7	20.0	100.0
	.	16	31.4	MISSING	
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	TOTAL	51	100.0	100.0	

VALID CASES 35 MISSING CASES 16

Source: (17)

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Vita

Alan Hamlin Russell, born of Elizabeth Preston (Boyd) and Winfield Palmer Russell in Boston, Massachussetts on the 22nd of August 1958, is happily married to the former Kimberlee Dawn Robinson of Bangor, Maine since September 1986 and is the proud father of their daughter, Christine Elizabeth, born September 1990. Alan has one brother, Dana Robert and one sister, Jacqueline Elizabeth (McKeen).

After graduating from Wiscasset High School in 1976, Alan entered work with his father, a well respected tool and die maker and veteran machinist. In 1981, Alan graduated from the Central Maine Vocational Technical Institute finishing near the top of his class with an Associate of Applied Science Degree in Machine Tool Technology. Continuing to work his way through school, he earned his Bachelor of Science degree in Mechanical Engineering Technology from the University of Maine-Orono where he also received his commission through the Reserved Officer's Training Corps on August 22, 1985.

As an Air Force Second Lieutenant, Alan reported for active duty to the Chanute AFB Missile Maintenance Officer Technical Training Center. Next, as a member of the 91st Strategic Missile Wing, his "Roughrider" esprit de corps helped the unit achieve the Presidential Excellent Installations Award. In May of 1990, Captain Russell enrolled in the School of Systems and Logistics' Logistics Management program, Air Force Institute of Technology.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
September 1991

3. REPORT TYPE AND DATES COVERED
Masters Thesis

4. TITLE AND SUBTITLE
AN EVALUATION OF THE IMPLEMENTATION OF TWO-LEVELS OF MAINTENANCE AT STRATEGIC AIR COMMAND INTERCONTINENTAL BALLISTIC MISSILE BASES

5. FUNDING NUMBERS

6. AUTHOR(S)
Alan H. Russell, Captain, USAF

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology
WPAFB OH 45433-6583

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GLM/LSM/91S-53

9. SPONSORING MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Michael W. Sayer, Lt Col, USAF
HQ SAC/LGBM
Offutt AFB NE 68113-5001

10. SPONSORING MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

As a result of the 1979 Defense Management Review, Headquarters, Strategic Air Command has initiated programs of alternative levels of maintenance in order to trim excess costs. This study investigates the suitability of the SAC program which changed selected base-level strategic missile maintenance tasks from three to two levels of maintenance. Using an opinion oriented questionnaire, this research surveyed a sample of missile maintenance personnel on their perceptions of the SAC program which implemented an alternative to intermediate-level maintenance. Analysis of survey results show respondents tended to believe the SAC program has not added benefit to their mission effectiveness. Other studies on applying two-levels of maintenance in a mature weapon system support the finding that significant gains are difficult to achieve--this study finds this missile system as no exception. The study recommends further analysis in the areas of spares requirements and pipeline constraints to assist future implementation decisions on alternatives to intermediate-levels of missile maintenance.

14. SUBJECT TERMS
Maintenance management, maintenance, logistics management, logistics

15. NUMBER OF PAGES
161

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

AFIT Control Number AFIT/GLM/LSM/91S-53

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